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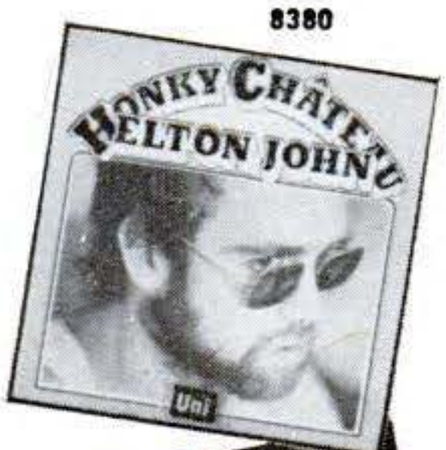

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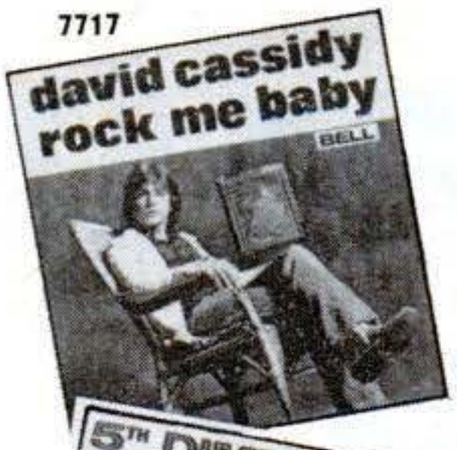

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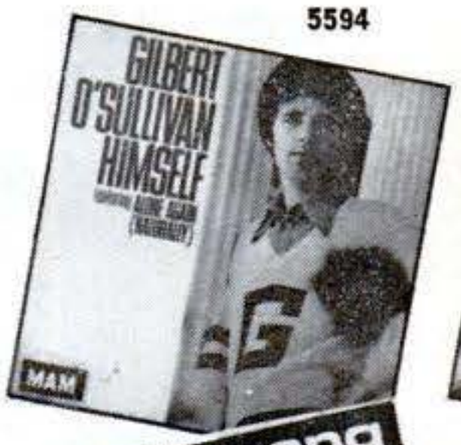

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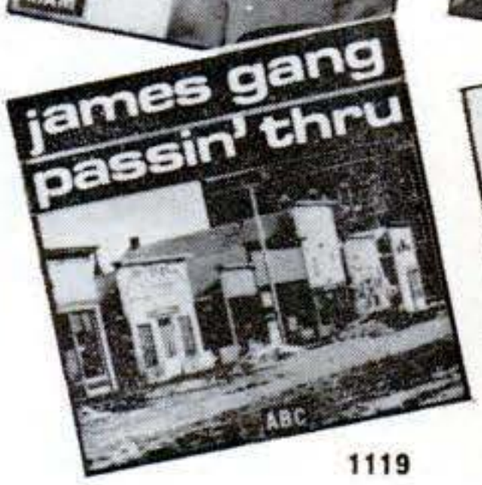

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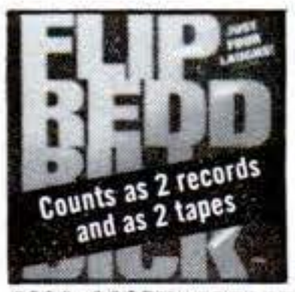

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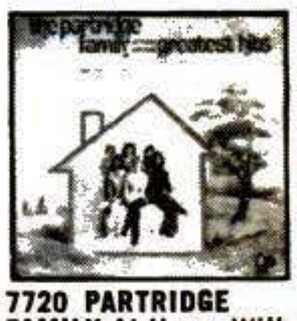

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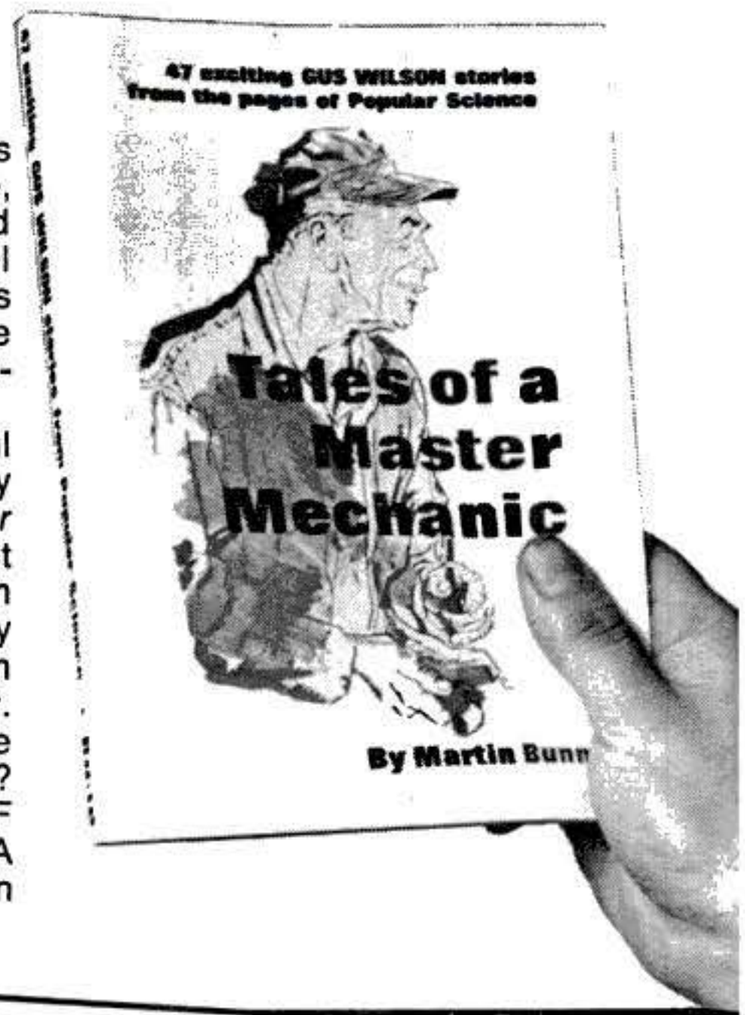

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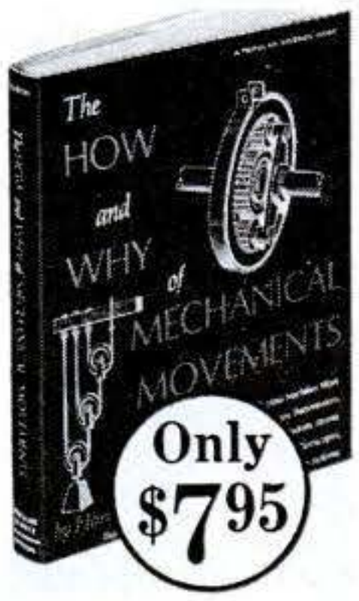

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PS Readers Talk Back

Where you voice your views . . . and the editors do the listening

Who "invented" slew-wing jet?

Your recent article concerning the scissors-wing aircraft ["'Flying-Scissors' Jetliner Cuts the Sonic Boom," Oct.] was interesting. In 1959 it was announced in the Japanese book *Airview's German Military Aircraft in the Second World War* that such a design had been tried by the Germans between 1942 and 1945. I enclose a copy of the appropriate pages from the Japanese text and a companion page from the English translation. It is difficult to tell from either the original or the translation whether the projects were actually flown or merely considered for flight. Dr. Jones did not "invent" the scissors-wing as you report; he did know when to exploit existing technology.

WILLIAM KINCHELOE,
Monte Sereno, Calif.

We didn't say that Jones invented the slew-wing concept, but rather that he designed this wing. You're right about the research the Germans did with the concept during World War II. Dr. Jones reports that the German design was classified military information during that period. The work you refer to was done by German engineer Dr. Richard Vogt. Interestingly, neither one knew of the other's work. To date Jones' design has been "flown" in the wind tunnel and in free flight (the model); Vogt's idea never got off the drawing board. Incidentally, both Vogt and Jones live in California now and exchange ideas through the mail.

TV interference—hams are clean

I would like to add a few statements concerning television interference from ham transmitters to "Your War on Electronic Pollution" [Nov.]. First, the majority of TV receivers manufactured today are not properly shielded, either

with filters or with chokes. In trying to save money, TV makers leave out vital chokes and filters to keep down the price of the finished product. This also goes for clock radios, hi-fi equipment, etc.

Second, hams must use a clean signal or lose their license. Also, ham transmitters have grounded shields covering the finals. Bad signals from a ham transmitter are the result of poor tuning, a fault of the operator.

If the general public were aware of what's needed in a TV receiver to produce a good picture, they would demand that manufacturers add proper chokes and filters to eleminate TV interference.

CORWIN ARNDT, WALRQ,
Nelson, Nebr.

Extend your swimming season

Last winter you showed us how a plastic "Air-House Pool Cover Sheds Winter Snows" [Feb.]. That's not why I made my cover (the photos show inside

and outside views). I use it to extend my swimming season from April to December. I inflate it in five minutes with a three-speed window fan, and keep it inflated only while swimming. At other times it floats on the surface. Heat loss and cleaning are greatly reduced. During the summer months, of course, I remove it. Total cost was under $100; replacing the plastic sheet each year runs around $8.

WILLIAM PIERCE, Berea, Ohio

The '73 cars (continued)

In "Before you Buy a '73 Car . . ." [Oct.] you indicated that the Pontiac Grand Am would sell for about $3600 with options such as power steering, power front disk brakes, handling package, and radial tires as standard equipment. The local Pontiac dealer in Pottsville, Pa., says the Grand Am retails for $4281 without radio and undercoating.

ROBERT MEROLA, Pottsville, Pa.

. . . You state, "Electric wires embedded in the rear window heat up the glass, melt ice, and defog the rear window." To my knowledge no manufacturer produces a backlite (rear window) that has wires embedded in it. The lines on an electrically heated backlite are made with a silver paste that is printed *on* the glass and then fired onto the glass surface during the tempering process.

JOSEPH E. POLEY, Rossford, Ohio

Studded tires in Maryland

I enjoyed "The Truth About Studded Tires" [Nov.]. However, in the table on page 77 you neglected to mention the

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regulations and restrictions on their use in Maryland. Much of the winter traffic between the Northeast and Florida goes through Maryland, so the stud situation there is of some importance. What about Maryland?

B. M. SCHARDT, College Park, Md.

Studded tires are okay in Maryland between October 15 and April 30.

The other side of the part shortage

In reply to George Meyer's letter about the replacement-part shortage [PS R.T.B., Oct.]: Mr. Mesa doesn't realize the inventory that even a small hardware store has to have. He wants a part

for a $4 item and then specifies what kind of handle he wants. Does he expect hardware stores to also carry them in colors? We have chisel handles that have been in stock for 10 years; they don't sell. Also, I can hardly see his comparison between a $3000 automobile and a $4 chisel or crescent wrench.

JACK SHARPLESS, Atmore, Ala.

The beginnings of meatless "meats"

Hal Hellman's interesting article "The Story Behind Those Meatless 'Meats'" [Oct.] was appropriately illustrated. I am, however, still puzzling over the ability of your writer to produce such an informative article without in any way referring to the Seventh-Day Adventist Church, which both inspired the production of "meatless meats" and has been associated with its entire development.

Your concluding sentence, "And this food revolution all began when a young man [Boyer] tasted artificial wool to see if it was 'ready,'" is clearly misleading. Indeed Worthington Food Co. was developed and operated by members of the Adventist Church, who utilized the denomination's extensive organizational resources for marketing their products. Although Miles Labs has recently bought out Worthington, and is currently expanding its market, these products are still being promoted and marketed through denominational channels. Furthermore, Adventists continue to constitute a hard core of its customers.

A. L. MOORE, Pastor, Brooklawn and Bethel Seventh-Day Adventist Churches, Bridgeport, Conn.

Renault ain't so slow?

The bog-slow acceleration (0-60 in 22.25 seconds) of your test Renault 12 wagon ["Subcompact Wagons—Ideal for Suburbia?" Nov.] may discourage some PS readers who would otherwise consider this car a good possibility in its class. I think that the 12 wagon is capable of much brisker acceleration, and suggest that something such as a malfunctioning secondary carburetor-barrel throttle plate (which I think is vacuum-controlled) was responsible for the lethargy you experienced. Following is a table that should suggest the Renault 12 wagon's normal performance.

Model	*Tester*	*0-60*
R-12	Road & Track	15.9 Sec.
R-15	Road & Track	15.7 Sec.
R-12W	Consumer Reports	18.0 Sec.
R-12	Motor Trend	14.3 Sec.
R-15	Motor Trend	14.2 Sec.
R-15	POPULAR SCIENCE	17.5 Sec.

My reading of these and other R-12/15 tests (the cars are almost identical, mechanically) and my consideration of such factors as weight, frontal area, and emission-control differences ('71 vs. '72) have satisfied me that the models in the above table are capable of similar acceleration, and the times given are valid indicators.

JOHN KNIGHT, Santa Rosa, Calif.

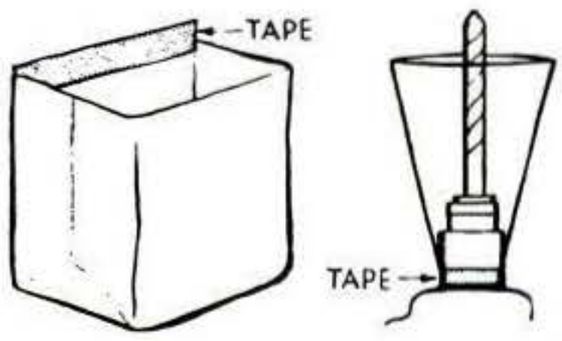
Wrong price on monitor

The price of our Atron Guardian Model 22 for monitoring freezers and refrigerators over the telephone is $100—not $59.75 as indicated in What's New in Electronics [Nov.]. The price you quoted is the price of our Model 33, which keeps tabs on heating systems over the telephone.

G. BREITBART, Atron Industries, Carle Place, N.Y.

Shortcut improvement

In the October issue of PS you show a method of catching dust when drilling holes in a wall [Short Cuts and Tips, p. 174]. This is fine, but I have an even easier one. Just cut the lower part of an



ordinary paper bag as shown in the drawing. Also, when necessary to drill holes in ceilings, I make a paper cone around the drill.

FRANK FUGEL, Clifton, N.J.

How big is the dome?

On your fine story "Building the Frame-Hung Dome" [Nov.]: The total of numeric figures used in describing its dimensions is 44 (give or take a few). Unfortunately, not one refers to size. What are the significant dimensions of this hovel?

TOM KIRKMAN, Seattle, Wash.

In our efforts to treat the subtleties of the dome, we neglected the obvious. Nominally, the dome is a 24-footer. Actual inside diameter at the floorline, however, is closer to 22 feet. The height from floor to apex is almost 15 feet.

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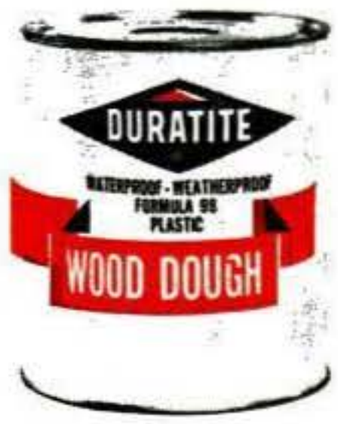

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Science Newsfront

Last-minute news and notes to keep you up-to-date

By ARTHUR FISHER

New lunar rover might have loop instead of wheels

This remote-controlled, battery-driven model of Lockheed's new moon-rover concept is trekking across a crumbly, hilly terrain like that on the moon. A continuous pliable metal loop would have inherent spring suspension, allow soft-soil climbs of more than 35 degrees. Unlike tractor-crawler tread, system requires no bogey wheels.

Fog alert for film

Planning to fly on your next vacation? If, like most tourists, you'll be carrying a batch of film for photography, you'd better not pack it in your baggage. Reason: Chances keep growing that it will be X-rayed by detection devices at airports. Best advice, according to Eastman Kodak, is to carry all film aboard with you in a carry-on case or gadget bag, labeled prominently "Film—Do Not X-Ray," and tell airport personnel what you've got.

New Ice Age coming?

An eminent climatologist has broken with long-held theories of past Ice Ages and, on the basis of new evidence, now believes that the world may be in for some uncomfortable climate in the relatively near future. Dr. Cesare Emiliani, a professor at the University of Miami's Rosenstiel School of Marine and Atmospheric Science, fears a new Ice Age could come within 2000 or 3000 years, or even earlier if man's contribution to climatic changes—through pollution, deforestation, and other means—should alter the present balance.

Dr. Emiliani based his concern on recent analyses of sediment cores taken from the Caribbean Sea floor. The temperature of seawater over hundreds of thousands of years can be extrapolated from the oxygen content of plant and animal life buried in such sediments. Dr. Emiliani's research shows, he believes, that in the last 400,000 years there have been eight eras of bitter cold, seven of raging heat, and about 30 less-dramatic fluctuations. This is a radical departure from the classical view that Earth experienced only four Ice Ages in the last million years, each lasting 100,000 years and separated by intervals at least that long. The evidence now shows, according to Dr. Emiliani, that periods of mild temperatures, such as we are now having, were short and unusual in the context of the last million years.

Deep drilling in the Antarctic

The National Science Foundation has announced that an international team of scientists will drill a hole nearly a mile deep into the bedrock of Ross Island early this year. It will be the first such probe of the Antarctic continent, and should provide detailed information on the mechanics of continental drift in the Southern Hemisphere over the last 200 million years.

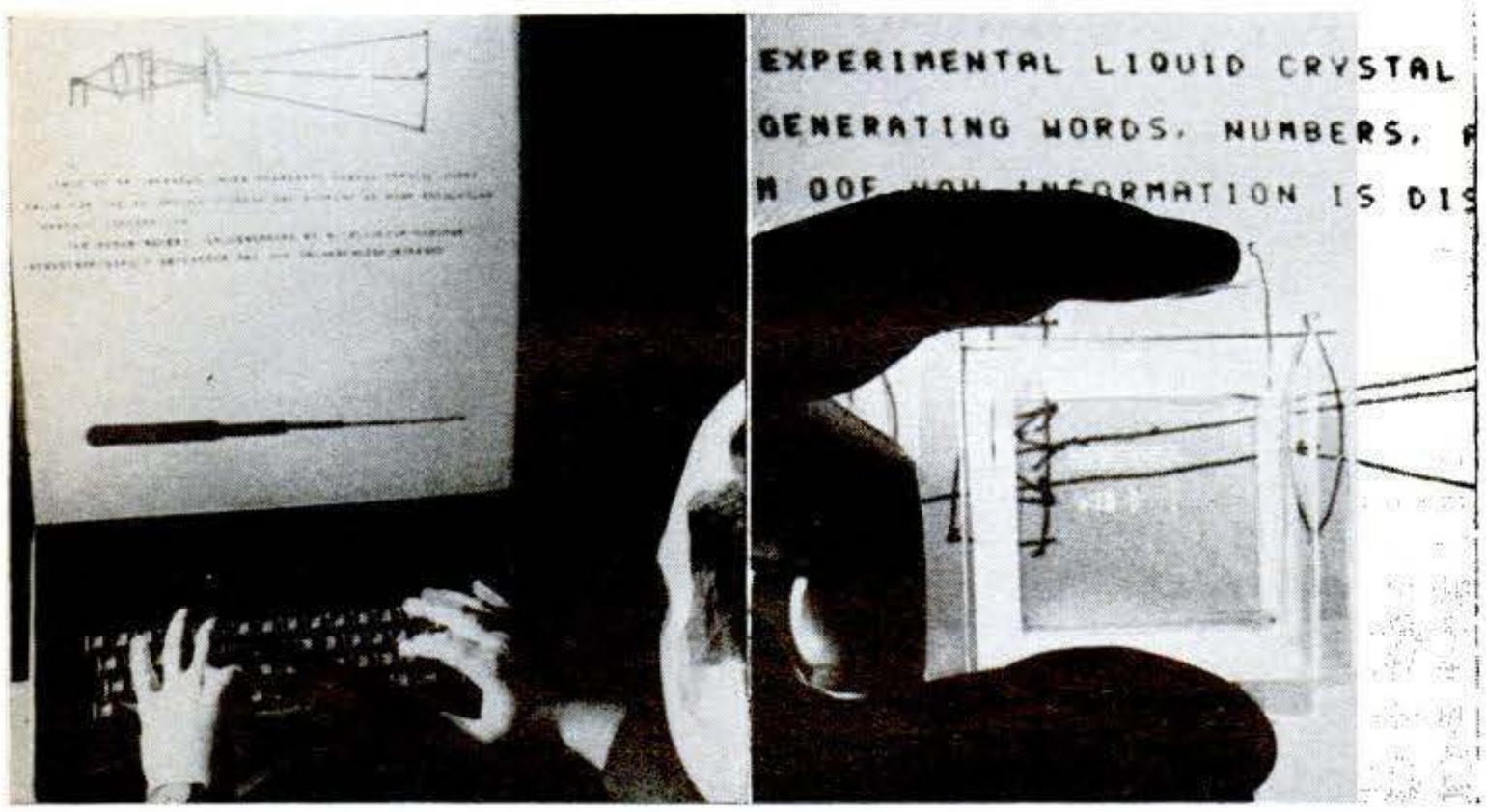
Flywheel for helicopters

Use flywheel-stored energy in a helicopter? Yes, but not to power the rotors. The U.S. Army, with Lockheed, is developing a helicopter rescue hoist that will get its lift from an on-board flywheel. Aim: to increase the lift speed from the present 100 feet per minute, using conventional motor drive, to a life-saving 500 fpm. A prototype will use a two-hp electric motor to start the flywheel and keep it spinning at 28,000 rpm, and a mechanical clutch to couple the flywheel to the hoist. The new system will make nine consecutive lifts without recharging. The motors of conventional hoists need cooling off after every other lift.

Frisbees flunk flare flying

Now why would the U.S. Navy spend $375,000 and four years doggedly spinning Frisbees off a 1000-foot Utah mesa and launching them in wind tunnels? To see if the plastic disks could keep flares aloft longer and for less money than the parachutes now used, that's why. Good idea? Sure. Did it work? Nope. Now maybe sea gulls . . . PS

Laser writing uses LC display for "remote blackboard"



A new system for transmitting and displaying written information, including text and drawings, has been developed by scientists at Bell Labs in quest of a "remote blackboard." It uses a low-power infrared laser to "write" on a liquid-crystal material sandwiched between glass plates.

An operator controls the laser writing from a keyboard (left). The resulting slide can be projected on a screen (right). A telephone link, carrying coded pulses of information, could theoretically separate the writing and display terminals.

The liquid crystal, normally transparent, becomes opaque where it is exposed to heat, thus enabling it to store information written on it by the laser. The crystal can be erased with an AC voltage, or, it can retain an image indefinitely.

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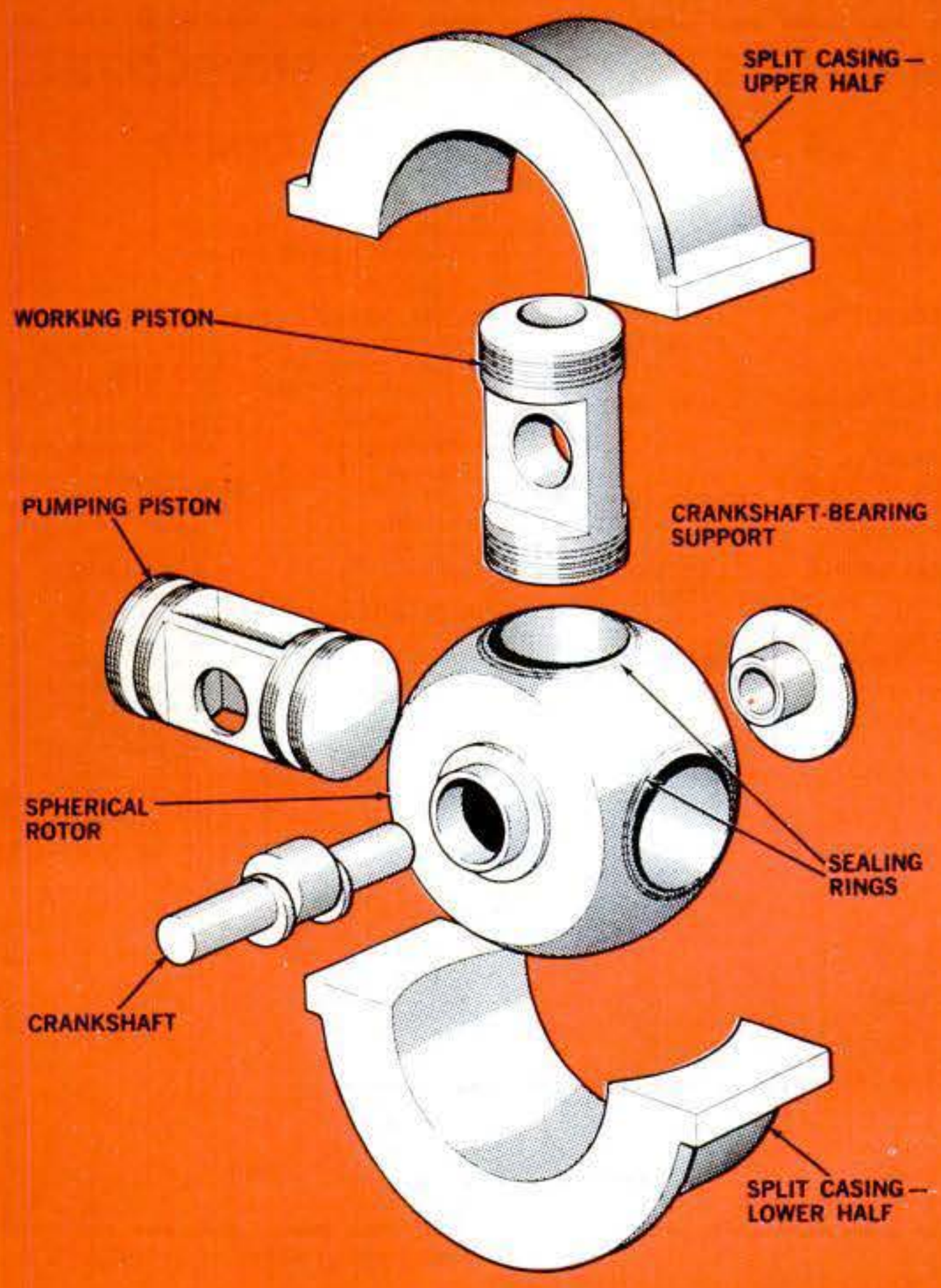
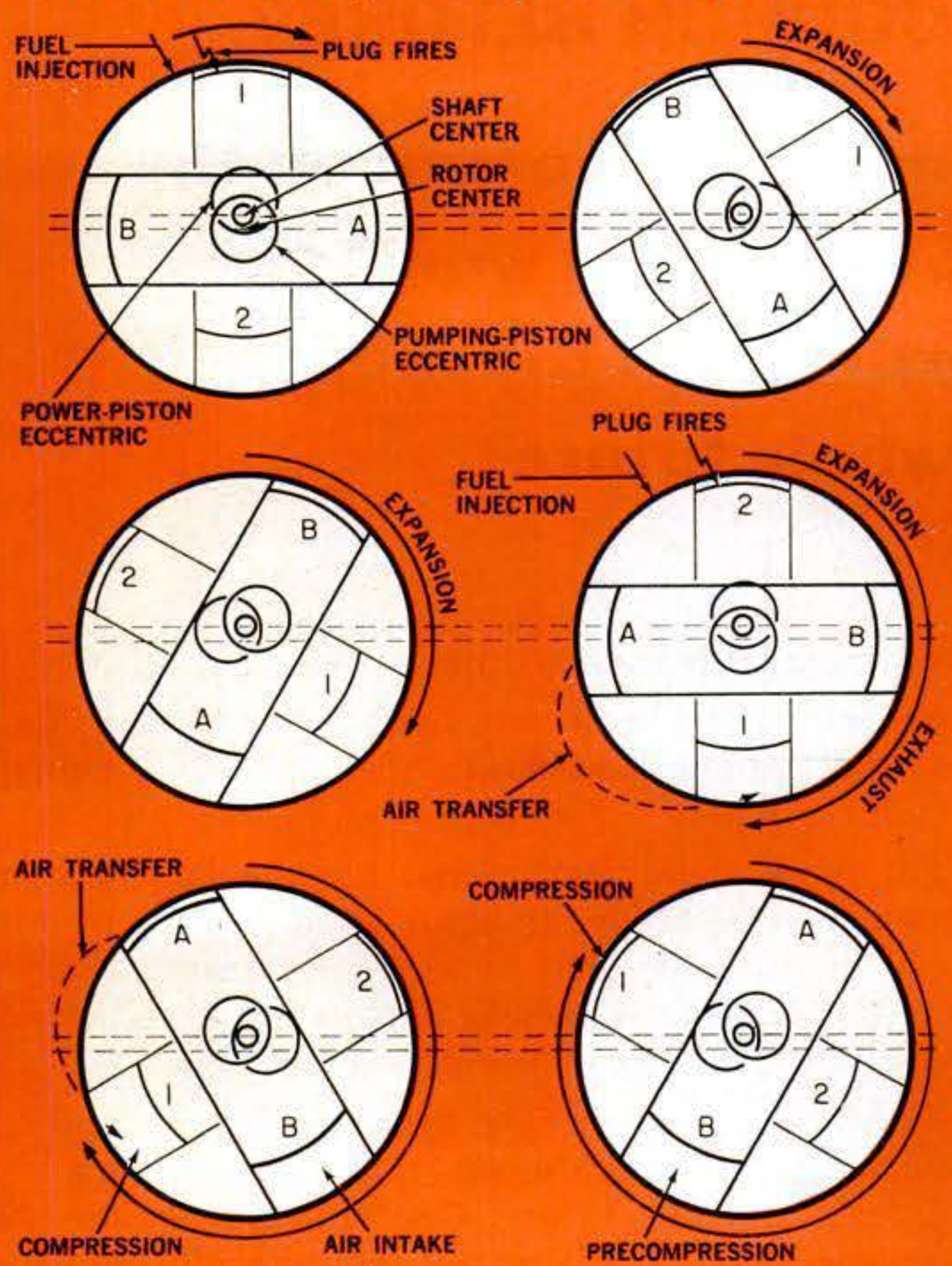


How the Anidyne engine works



Rotor has four cylinders in X formation, with double-ended pistons acting on opposed cam-like circular eccentrics on the output shaft. The revolving cylinder block turns at half of shaft speed.

ANIDYNE ENGINE:

Clever Rotary with Pistons

This new Anglo-American invention is full of promise, but strictly experimental

By **DAVID SCOTT** / *PS European Editor*

Under heavy wraps in a back-room workshop of one of Britain's largest engineering companies a new rival to the Wankel is taking shape. It's an amazingly simple rotary with conventional pistons. It is self-balanced, has a low surface-to-volume ratio and thermodynamic advantages that should reduce both exhaust emissions and fuel consumption, and is capable of diesel compression ratios.

Is it an automotive engine? It's too soon to tell, for the Anidyne is still experimental. But it has the backing of some very high-powered industrial concerns.

How does it work? It's a four-stroke, with one power stroke for every crankshaft revolution. The cylinder block is a spherical rotor. Two intersecting cylinders are bored radially through the center at right angles to each other. In each cylinder is a double-ended piston. Flat central portions are interleaved like a Chinese puzzle, so they can slide freely. Passing through the rotor axis, but offset by a quarter-stroke, the crankshaft has opposed cam-like circular eccentrics set 180 degrees apart. These engage bearing holes centered in the middle of the two pistons. This assembly is enclosed by a casing that serves as the cylinder head. The close-fitting head face includes ports and a single spark plug. It is designed for fuel injection.

An ingenious feature of the operating cycle is the separation of induction and exhaust-scavenging from the power phase. These functions are handled independently by the two pistons. One is a double-acting air pump, the other an actual power piston. Since the piston has two crowns, there are two power impulses for every turn of the rotor (one per shaft revolution).

Scavenging burned gas. The pumping piston feeds a gas-air mixture through the intake port. Then, on its outward stroke, it compresses the charge in a way similar to the crankcase compression of a two-cycle engine. As the rotor continues to turn, a transfer port in the housing opens, and the charge rushes into the adjacent power cylinder, with piston at bottom dead center. The precompressed mixture scavenges residual burned gas.

Final compression takes place in the working chamber. When the working piston reaches top dead center it aligns with the spark plug, which now fires for the power stroke. The same sequence is duplicated at opposite ends of the two cylinders. Power impulses are passed to the crankshaft through the circular cams, but because the shaft is displaced from the axis of the sphere a wedging action imparts its turning motion to the rotor.

Not yet tested. The basic rotary conception was invented by Robert Karol of Oxford, Ohio, then developed and refined by Richard Ansdale, a leading expert on rotary engines. World rights to the Karol patents are held by Anidyne Corp. of Harrisburg, Pa. The prototype is being built by Associated Engineering in England. PS

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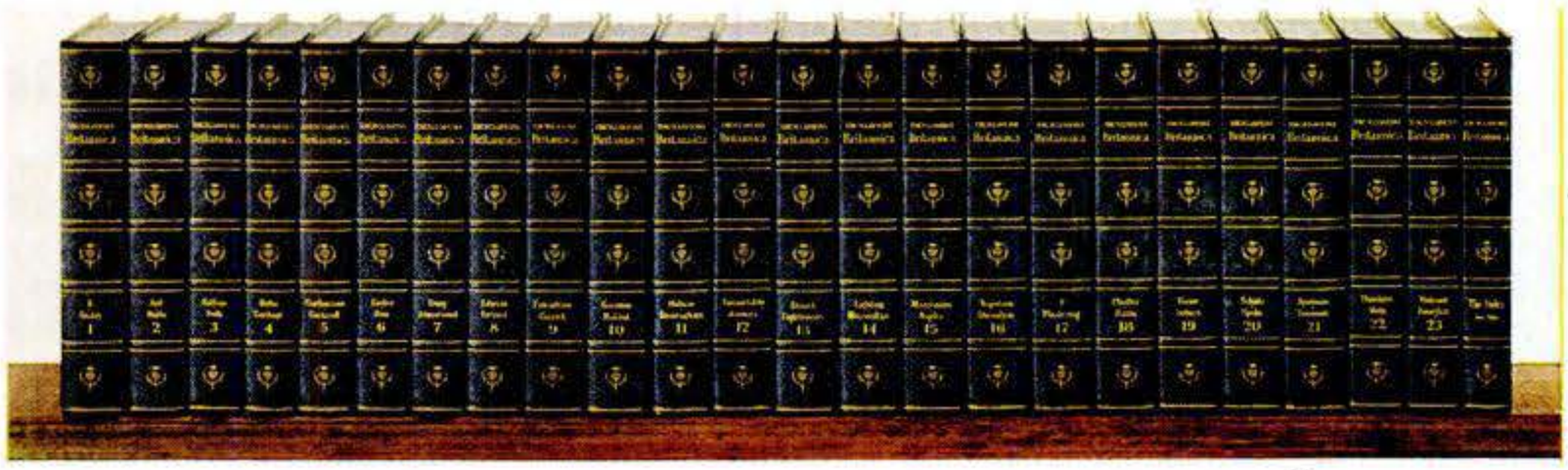

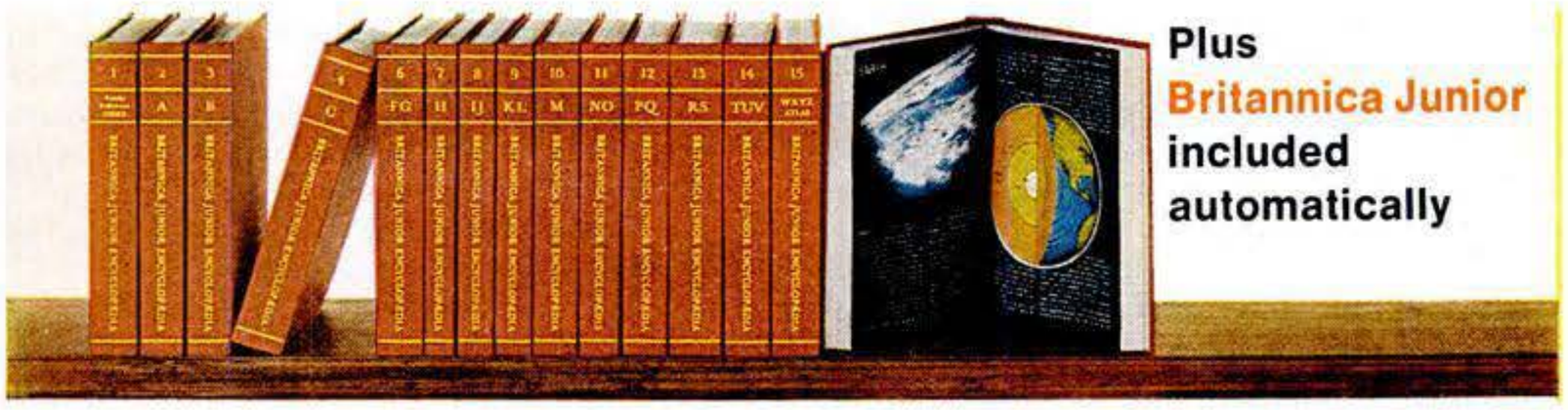

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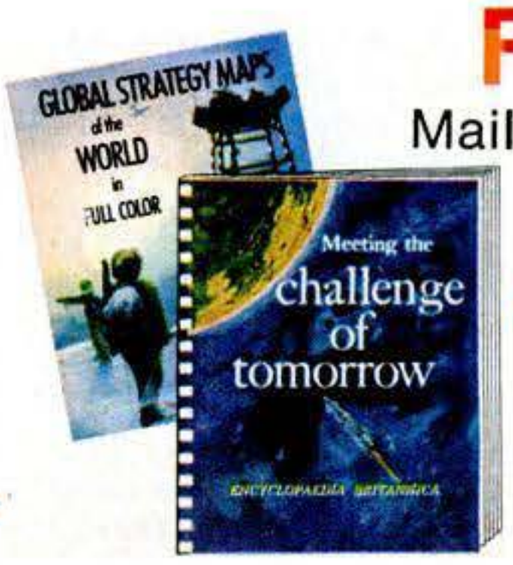
I invite you to join in this occasion. Nothing would please me more than to give you the opportunity of showing you how Britannica can enrich the lives of you and your family.

Wm Benton



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The View Down the Road

...news and comment on cars and driving

By JAN P. NORBYE / *PS Automotive Editor*

DATELINE: STUTTGART, GERMANY

Mercedes and the emission standards

As you know, Stuttgart is the home town of Mercedes. I came here to discuss the U. S. emission standards for '75 and '76, and had a long meeting with Kurt Obländer, chief test engineer for passenger-car engines. Shortly before my arrival in Stuttgart, Honda had announced its ability to meet the '75 rules with the compound-vortex-controlled combustion engine, and General Motors had released the news that prototype emission-control systems in experimental cars at low mileage had been able to meet both '75 and '76 standards. The striking fact in both cases is that the conventional piston-type internal-combustion engine is retained. This is not surprising, in view of the statements made by Carlo Pollone of Fiat in my interview last month. But what would be the reaction at Mercedes-Benz?

Burn more gas for cleaner air?

Kurt Obländer told me that Mercedes-Benz had tested experimental piston engines with a catalytic oxidation converter plus supplementary air injection, exhaust-gas recirculation, and various minor modifications. This system meets or exceeds the '75 standards. However, the required 50,000-mile durability of the catalyst is in doubt, even with no-lead fuel.

It's a noble metal in monolithic support, manufactured by American Lava. And fuel consumption is at least 15 percent higher than on '73-model engines. The experimental '75 engine will cost 72 percent more than a '65 engine (without emission controls except for the positive crankcase ventilation).

For '76, the picture looks even worse. The necessary "package" is still theoretical, and cost has been calculated at 98 percent above 1965. This presumes use of piston engines. What about alternative power systems? The first possibility Obländer brought up was the diesel engine. It's still an internal-combustion reciprocating-displacement engine, but it burns heavy oil, and works by compression ignition rather than spark ignition.

Mercedes-Benz has produced over a million passenger-car diesels, and the existing models can easily meet '75 standards. But it can't be modified to come down to the '76 NO_x limit. It puts out three times more NO_x than will be allowed in '76. The reasons are fundamental: 1. The diesel cannot tolerate more than a very low percentage of exhaust-gas recirculation without total loss of ignition. 2. Catalytic converters cannot be used, because the diesel emits soot, which destroys the catalyst.

Rudi Uhlenhaut, the recently retired chief engineer of passenger-car development, testified before the Environmental Protection Agency last April: "It is not conceivable that the law contemplates switch-over to diesels for one year when there is no assurance of satisfying the standard . . . for the following year."

High hopes for the Wankel

You and I can only conclude that the diesel is not a valid long-term alternative. What else is Mercedes-Benz working on? The Wankel, of course. Obländer says the Wankel can be made to meet the '75 standards without a catalyst, using only a thermal reactor. This corroborates the testimony given before the EPA by Dr. Takushi Mitsunari of Mazda with regard to their work on cleaning up the Wankel.

"For '76," continues Obländer, "the Wankel could possibly meet the standards using two catalytic converters in combination, without a thermal reactor." The uncertainty is explained by lack of test results. Obländer worries about the back pressure created by catalytic converters. This is no problem in four-cycle piston engines with poppet valves, but can be a problem in the Wankel, which breathes through ports.

Preliminary tests have been made, however, with some very interesting findings about the Wankel relative to the reciprocating engine. For 1975, the Wankel would prove far superior in terms of NO_x emissions, but somewhat worse for CO emissions—and much worse for HC emissions. The Wankel would be easier on octane requirement, but worse on fuel consumption and loss of power. Cleanup cost would be higher for the Wankel. Mercedes-Benz feels that the Wankel is not a good solution for 1975.

'76 picture changes completely

Because the emission-control system is totally different, pollutant levels also change. The '76 Wankel would equal the '76 piston engine in terms of HC emissions, and be slightly better for both CO and NO_x.

Power losses would be equal, but fuel economy would be better in the Wankel! Finally, cleanup cost would be higher for the piston engine. That should cinch it for the Wankel in '76. Now, does Mercedes-Benz intend to convert 100 percent of its passenger-car production to Wankel engines by that time?

The answer: The Mercedes Wankel engine is at present "in a pre-development stage." Installation in a car and testing with full emission-control equipment have been performed. But "assembly-line production of emission-control systems for the Wankel engine is dependent on the possible introduction date of the engine itself for mass production. That will not be possible for model years 1975-76."

I'm disappointed that so much time is needed—but encouraged that Mercedes is going ahead with the Wankel with all deliberate speed. And it's important to look for what the official statements *don't* say. Nothing has been said that precludes limited production ahead of 1975. That's almost a prerequisite for such a major change. For instance, Citroën built its first series of 500 Wankel-powered cars in 1970, with mass production startup scheduled for June, 1973.

Modular Wankel engines

The Mercedes engine described as being in the "pre-development stage" is in reality a whole family of engines. Adoption of the modular-construction principle can give a range of engines from 150 to 300 hp, using only standardized parts. With engines of two, three, and four rotors, all rotors can be identical. This is what Mercedes is preparing.

The twin-rotor unit is the one you'll see first. It will go into the 200 and 220 models in place of the existing four-cylinder engines. The four-cylinder Mercedes engines are the least satisfactory in the whole line—they have the lowest power-to-weight ratio, and they suffer from a certain roughness. It's only logical that they should be the first in line for replacement by the lightweight, compact, and vibrationless Wankel.

One delay in introduction of the Wankel engine in Mercedes-Benz cars has been the self-imposed requirement that the Wankel must have equal or longer life than the extremely robust and long-lasting piston engines now powering the cars from Stuttgart. According to engineer Heinz Lamm, who works in Obländer's group, there are now no wear or durability problems in the Mercedes Wankel. PS

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Zack and Karen Taylor, whose hobby is home movies, help put Montego's ride to a rugged test. First a movie camera is mounted on the axle.

Then Karen drives the 1973 Montego through scenic California horse breeding country, while Zack shoots from inside the car.

At 15 to 20 mph, it's easy to see the wheel camera is getting a bumpy ride. The pictures it takes show how rough that road really is.

But Zack, shooting at the same time, is getting sharp, steady pictures that show how smoothly this personal size Mercury rides.

Demonstration supervised by Nationwide Consumer Testing Inst., 1973 Montegos now available with optional engines and power trains.

We filmed wild horses from a moving 1973 Mercury Montego to demonstrate our personal size car has the ride of a big car.

The 1973 Montego is about a foot trimmer than most big cars. Yet this personal size Mercury has a smooth, steady ride that rivals the best of them.

That's because Montego is built to Lincoln-Mercury's high standards. On an extra-wide track. And the same type high stability suspension system used in our most expensive luxury cars.

Front disc brakes and flight bench seat are standard on the 1973 Montego MX Brougham. The vinyl roof, white sidewalls, luxury wheelcovers and bumper rub strip (shown) are optional. Try a test ride at your Lincoln-Mercury dealer. Bring your own camera.

Built better to ride better.

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Recreation Roundup

. . . on the go with PS

By HERBERT SHULDINER

New mass-produced dune buggy on the way from VW

The long-awaited entry of VW into the dune-buggy market has finally come about. VW will import a Mexican-made 181 utility vehicle into the U.S. this year—the first made-in-Mexico vehicle to be marketed here. The 181 has the air-cooled 46-hp rear engine, with top speed of 68 mph. Weighing just under 2000 pounds, it is 148.8 inches long, 64.6 inches wide, and 63.8 inches high. Ground clearance is 8.1 inches.

Coming: a motorcycle ESV

The great publicity recently given auto experimental safety vehicles (ESVs) has overshadowed the development of two-wheeled ESVs. Douglas Toms, who runs the National Highway Traffic Safety Administration, says that his agency has been working with Honda, BSA Triumph, and other cycle companies on an experimental safety motorcycle. The new bikes will have better crash survivability, braking, handling, and stability, Toms says. They will also have better lighting and location of controls, along with improved fire- and explosion-prevention. However, he has not put a date on when the two-wheeled ESVs will be delivered for testing by the NHTSA, or when the improvements will be incorporated into the bikes you buy.

Do-it-yourself outdoorsman

Virgil Erickson, of Racine, Wis., sends along this tip for leveling RVs. Screw a small bracket to a window frame, and drop a sinker on a fish line from it. Level with a bubble level, and X the spot where the sinker points (a bin door here). Then you can level repeatedly without use of a bubble level.

Improved bumpers complicate towing

Detroit is warning its customers who buy cars equipped with the new energy-absorbing bumpers that installation of certain hitches could reduce or destroy the new bumpers' effectiveness. This is especially true if you use a Class I or II hitch that attaches to both the frame and the bumper. These will stiffen the bumper and prevent it from "stroking" when hit.

American Motors has warned buyers of Gremlins and Hornets with optional five-mph energy-absorbing bumpers that the bumpers do not work when hitches are attached this way.

Ford has devised a new hitch for pulling Class I trailers with its standard Ford and Mercury cars that does not attach to the bumper at all. The new hitch has an extended drawbar that clears the bumper. When you're not towing, the extension can be removed by taking out a couple of pins. Sturdily built, the new Ford hitch will certainly cost more than a conventional Class I hitch.

Draw Tite has a new type of Quik-Lok hitch available for Class I or II towing that is also designed to solve the problem. This one, too, has extended drawbars that can easily be removed when you're not towing.

If you buy a '73 car with energy-absorbing bumpers, ask your dealer to help you select a hitch that will not impair the bumper's effectiveness. Confronted with differences in design of the new bumpers and hitches intended to work with them, caution is the password.

Fifth-wheel hitches for cars?

Detroit may be taking a serious look at providing fifth-wheel hitch capability in autos. PS Detroit Editor Jim Dunne tells us he's seen an experimental Lincoln outfitted with a fifth-wheel hitch being tested at the Ford proving grounds in Dearborn, Mich. One good reason for choosing a Lincoln for the tests is its huge trunk, which not only permits installation of the hitch, but also lets engineers cram in lots of instruments to monitor the tests. The Lincoln also has a heavy front end to balance weight.

Tips on changing snowmobile plugs

Let your snowmobile engine cool off before you replace its spark plugs. That's the advice of AC engineers, who say that replacing plugs in a hot engine could strip the heads. This is especially true in mills that have aluminum cylinder heads. AC engineers found in recent tests that it takes much more torque to remove plugs when they're hot. The reason? When the engine stops running, aluminum heads cool rapidly and tighten around the slower-cooling plugs. The added tightness could strip soft aluminum heads if plugs aren't removed just right. It is particularly dangerous if plugs are overtorqued.

Refueling? Turn off RV pilot lights

The Recreational Vehicle Industry recently pointed out a little-known danger that exists when gassing up a camping vehicle. Mike Radigan, RVI national director, says there's danger that gas fumes could be drawn into appliance vents when refueling and be ignited by a pilot light. He advises RV owners to turn off all pilot lights and appliances while filling up at a gas station. "It is inconvenient," Radigan says, "but it's better to risk having your ice cubes melt than to take a chance on having a serious fire in your RV."

Things to write for

"Winter Sports" is a new catalog from Sears featuring equipment for skiing, snowmobiling, hockey, and other winter outdoor activities. You can get one from Sears stores, or Dept. 139, 925 S. Homan Ave., Chicago, Ill. 60607.

Wares Cycle Company, 2656 North Wauwatosa Ave., Milwaukee, Wis. 53210, offers a new catalog of bicycles, parts, and accessories, which you can get for $2.

"Kit for Concerned Snowmobilers" answers commonly asked questions about the sport. You can get a free kit from SIIS, Box 35304, Minneapolis 55435.

You can get a free brochure on the National Safety Council's "All About Bikes" program from their Youth Dept. at 425 N. Michigan Ave., Chicago. PS

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"I've never performed on a better tire."

Stunt driver, Carey Loftin, put Shell's new Steel Belted Tires through every driving test he could dream up. Here's what he said about them.

A report from Carey Loftin.

SHELL: Tires are very important to a stunt driver, aren't they?

LOFTIN: Yes they are. You have to depend on your tires, first; engine, the rest of the car, second.

SHELL: You just tested Shell's new Steel Belted Tires. In general, what do you think about them?

LOFTIN: Well, I felt very secure, very safe at all times, no matter what I did. I never had one fear of failure at all.

SHELL: At one point you drove over some wet pavement, what about the skid resistance?

LOFTIN: It seemed very good and very equal and very little sway whatsoever. I was really amazed that I could hold the car as straight as I did.

SHELL: You also did some quick stops from 80 miles an hour on this wet stretch of track. How did the tires react?

LOFTIN: They all seemed to react the same. I thought I would be real busy correcting, trying to hold the car straight. But, with very little correction, I was able to stop practically in a straight line.

SHELL: What about on the slopes and the curves, did you notice much roll-over or squirming on the part of the tires?

LOFTIN: No, they didn't. They felt the same all the time. The tires, the steering geometry never seemed to change at all.

SHELL: Carey, do you have any relatives?

LOFTIN: Yes, I do.

SHELL: Would you recommend Shell's new Steel Belted Tires to her or him?

LOFTIN: To any of them I would. I have three sisters and a brother and I would recommend them to anyone. I think they are amply safe for the even better than average driver, not even the average driver, above average. I would say that you are amply safe with the Shell tires.

SHELL: Carey, do you have any other comments you would like to add to this at all?

LOFTIN: Not specifically. I can only say in general, I've never performed on a better tire. It seemed to hold its shape and stand up. So, in general it is one of the best tires I've ever driven on.

Ask an expert. Shell products perform.

SHELL

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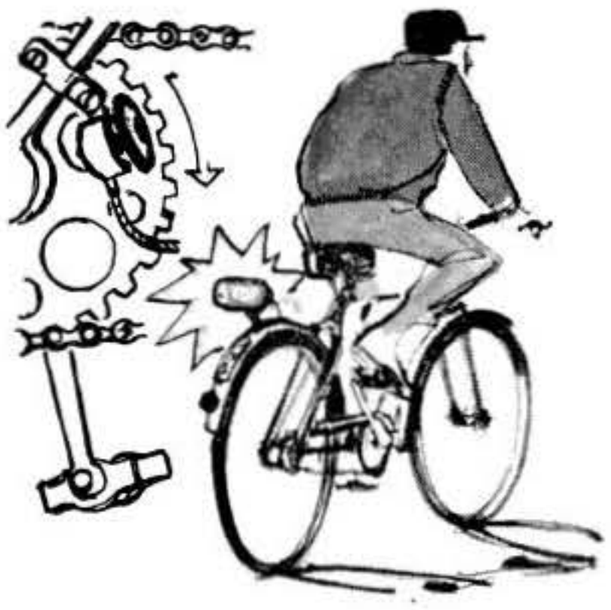
New Ideas from the Inventors

ILLUSTRATIONS BY DANA RASMUSSEN

Ice float aids rescue. With his weight distributed over the surface of this long, flat boat, a man could move over thin ice with relatively little danger. Lying prone, he could propel this recently patented craft to a break area by using hand-held picks. Even if it cracked the ice, the lightweight boat would float rescuer and victim until it could be hauled to shore.



Bike sprocket switches stoplight. Bearing against the side of a conventional sprocket wheel, this friction switch would normally hold a lamp circuit open when a bike was in motion. But braking action that reversed sprocket direction would close the switch and turn on a fender-mounted stoplight.

Tongs place fire log. The narrow jaw angle of most fire tongs makes it difficult to place a large log securely and accurately. Adjusting easily to any log length, these two heavy-wire tongs would let you use your hands and forearms to exert lifting pressure, then release the properly positioned log.

Paint apron eases trim work. Baffled to prevent sloshing, fluid-tight pockets in this apron would hold useful quantities of paint. You'd use it to gain extra mobility on ladder jobs and for trimming and the like. Brush-wiper bars across the pockets would serve as supporting, shape-holding frames.

Blade de-ices stairs. Notched to fit snugly against the tread, riser, and nose of a step, this scraper would both speed and improve stair cleaning, help to chip away clinging icicles that often make outside steps hazardous. Notched on one shoulder, the blade would reach under a step's overhang. The handled scraper could also be used like a conventional blade.

Tractor hauls skier. With his skis set into footrests attached to this tractor, a cross-country traveler could get a considerable assist on long or uphill treks. A flexible cable connected to a ski-pole trigger would throttle the endless, cleated crawler belt. The lightweight gas-powered tractor could be hauled or back-packed, as preferred, on downhill runs.

The following patents have been issued on these inventions: **Rescue boat**—*No. 3,532,066 to R. E. Clemans, Kankakee, Ill.;* **Bike light**—*No. 3,571,792 to F. Sullivan, Canoga Park, Calif.;* **Fireplace tongs**—*No. 3,574,380 to R. J. Tague, Wonder Lake, Ill.;* **Paint apron**—*No. 3,535,709 to J. H. Johannes, Robinson, Kans.;* **Stair scraper**—*No. 3,571,838 to M. P. Staschke, Chicago;* **Ski tractor**—*No. 3,568,787 to H. Gremeret, Menton-Alpes-Maritimes, France.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if the address given here is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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KOOL Filter Kings MILD MENTHOL CIGARETTES

Milds 14 mg. "tar," 1.0 mg. nicotine av. per cigarette, by FTC method. Kings 18 mg. "tar," 1.5 mg. nicotine; Longs 18 mg. "tar," 1.4 mg. nicotine av. per cigarette, FTC Report Aug. 72.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

KOOL Milds

14 mg. tar, 1.0 mg. nicotine

Now, lowered tar KOOL Milds

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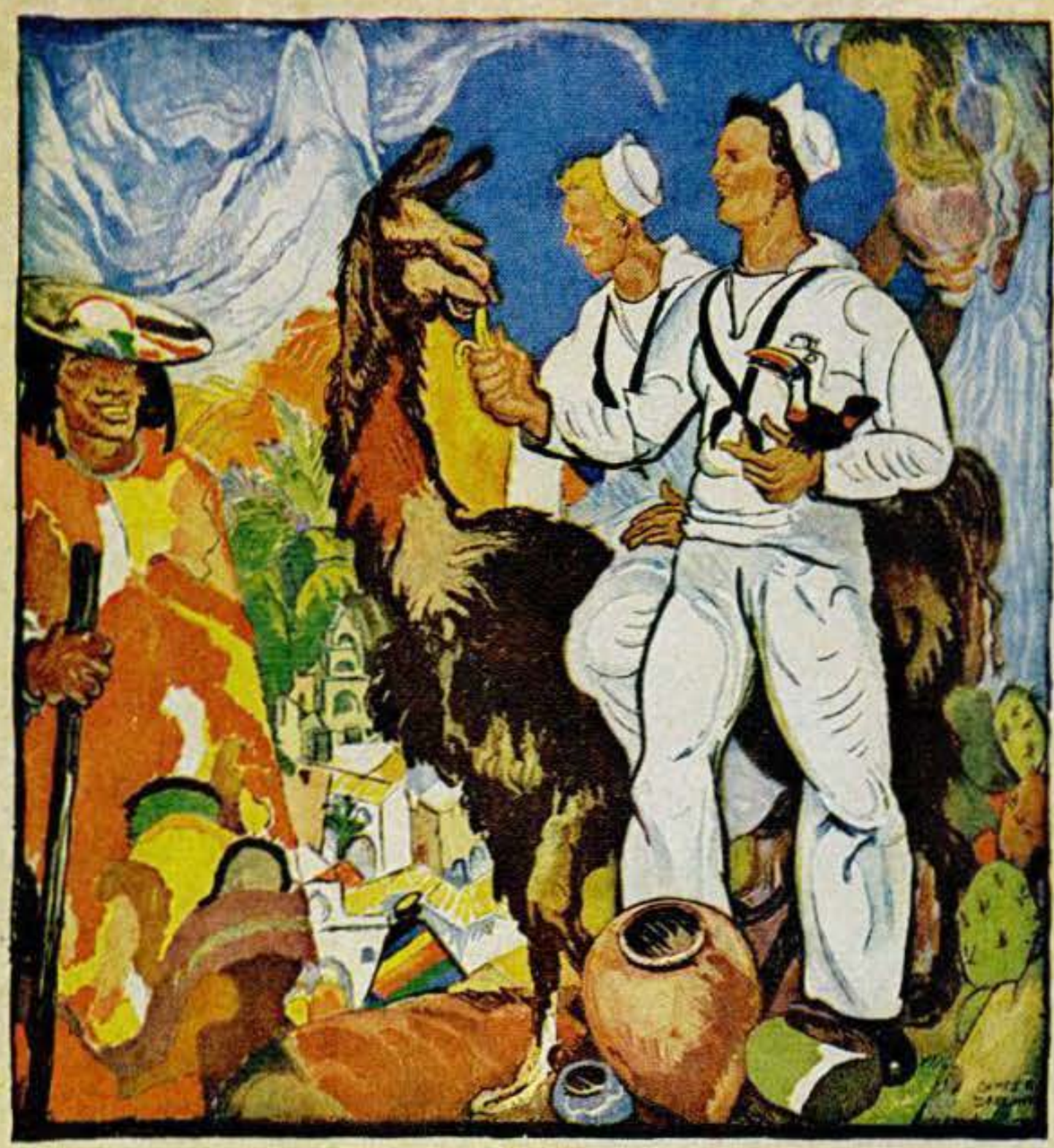
1919: Join the Navy and see exotic places.



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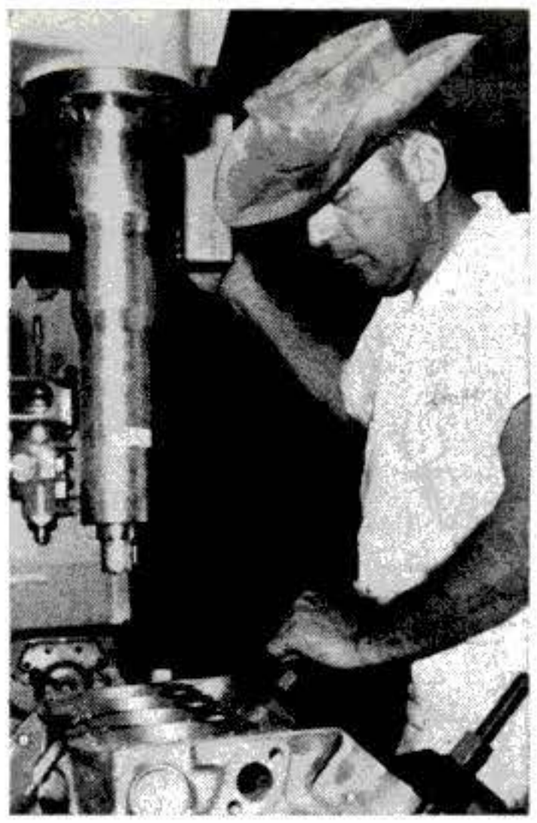
"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 355 Lexington Ave., New York, N.Y. 10017. Questions cannot be answered by mail.



I have a 1971 Buick Electra, 455 engine with four-barrel carburetor, and 17,000 miles on it. Now it's in the repair shop with four burned exhaust valves. I'm confused because I have followed dealer and manual instructions to use regular gas with low lead of 91 octane or more. I occasionally use premium gasoline for pulling a medium-sized trailer. I would appreciate your advice as to just what gas to use, so the valves won't burn again.

A. F. MANSHEIM, Clovis, Calif.

Your engine should get along fine on regular fuel, but with lead. I don't think premium fuel will hurt it, but in my opinion it's a waste of money, since you'll probably get more miles per dollar on regular fuel with lead. At risk of catching hell from the experts, I'm gonna say that before they remove the lead from gas, they had better come up with something as good or better—or there'll be a tremendous boom in exhaust-valve sales. I'm sure there is another way, but what it is must be hidden from me by all the bull I see and hear.

I put oil in the crankcase of my 1968 Coronet with 440 engine—right up to the full mark on the stick. Next day it's down to "Add Oil." And all I did was go to work and back. This car doesn't smoke when I step on the gas, and no oil leaks onto the ground from any of the seals. The outside of the engine is dry. I don't have a PCV valve on the engine. Do you have any idea where the oil is going?

R. E. PARKER, Dunedin, Fla.

Look at the owner's manual and see how much oil the engine should hold. Drain the oil after the engine hasn't been run for one hour, then fill with the amount called for in the manual. Read the dipstick now. Assuming it is correct, then you are burning the oil—there's no other way. It is possible to burn oil and not see the smoke—unusual, but possible. Now if it reads one quart low on the proper full amount, re-mark the dipstick on the next oil change at two-quart and one-quart low, and make a new full mark.

Another thing: A lot of engines burn the first quart rapidly because (since the engine needs a splash pan to keep the crankshaft out of the reserve oil) the crankshaft throws oil up the cylinder walls and overloads the oil rings. But this only happens if you drive hell out of it.

My 1969 Volkswagen has only 18,000 miles on it, because it spent the first 18 months not being driven. After about 6000 miles, the throwout bearing started making noise and I had it replaced by my dealer. Since then it has been changed six times, and two dealers could find no reason for it to keep going bad. Both said the cross shaft looks okay. Any ideas?

MARVIN L. WEISBERG
Staten Island, N.Y.

Yes, it's running all the time because it does not retract and quit spinning when you remove your foot from the clutch. If you don't believe it does this, just crawl under and check if the "fingers" are up all the time. When it's retracted there should be at least 1/8-inch clearance between the bearing and the clutch fingers.

I have a 1970 Cutlass S with full power and drum power brakes. I'd like to put disk brakes on this car, inexpensively if possible. Recently in a salvage yard I found a '71 Cutlass front end with disk brakes (rusting away). Will this unit bolt into my car? Are there any problems to watch in valving of the master cylinder or in the exchange in general?

JAMES CHALUPSKY, Iowa City, Iowa

There are certain mechanical differences between drum and disk brakes that don't make this a good idea for a layman to play with. For a quick example, brakes need to be balanced front to rear size-wise and pressure-wise. Also, disk brakes require a residual check valve but drums do not. Your brakes could decide the time you spend here on earth, and from the questions you've asked I'd advise—for you to prolong your stay here—don't make this switch yourself.

I'm thinking of making my own mid-engine car using a wrecked Chevy El Camino—because it has rear shocks rather than leaf springs, so I can cut away all of the body overhanging the rear axle. Also because it's made with a frame, so I can shorten it and then make my own dune-style body. I plan to use a 327 small block with Chevy's four-speed cluster box tied into the 12-bolt rear end. What sort of trouble can I expect, other than remounting the engine, shortening shift linkage, and getting the brakes readjusted to the new weight distribution? Do you think there will be any problems in handling because of the shortened frame? Any help would be greatly appreciated.

SCOTT ACHELIS, Los Altos, Calif.

The answer to your questions would be a complete engineering course on chassis design and manufacture. This is going to cost money and lots of it. It is a good idea and could be made to handle very well. Probably the reason our cars aren't all mid-engine is because of the impracticability of this design in light of the average car-owner's space and seating needs.

I need help. My late-1971, 150-hp Hornet bought with only five miles on the odometer now has less than 400 miles on it, yet I can get at the most 14 mpg, and I know I should be getting better mileage. Had the car in twice for a checkup; no charge, but the service manager said that due to such a small gas tank, the meter needle goes down faster. What a nut he is!

M. C. MARTINEZ, Norwalk, Calif.

Mileage is a can of worms now, but 14 mpg ain't bad in traffic. Three different drivers will get three different mileage readings in the same car. How about you? Are you a good economy driver? Do you have a good rear axle for mileage in your terrain?

Back to the engine: The biggest causes of poor mileage are: a rich carburetor setting and late timing, with strangulation of the engine; poor low-speed power via the emission controls. I'm afraid you're going to find that your carb and timing are off from maximum mileage settings on purpose, to pass emissions requirements. I can't in my wildest dreams figure how in the hell one can go a lesser distance on a pound of fuel and cut down pollution. But that's the way it is. And if you change it, you'll violate the law.

Two questions: (A) I'd like to thoroughly clean the old oil out of my engine. How do I go about flushing it out? (B) Of all the oil filters on the market are there any outstanding, or are they all about the same?

SAM MCCOY, Perrysburg, Ohio

(A) There are many canned engine oil flushes on the market sold under manufacturer trade names, and also some independents' products that are good for flushing—one is Rislone. If you're an expert you can do a good job of flushing with mineral spirits—but this is not for an amateur. (B) Most of the filters are good, and I don't know any one that stands out above the rest. Car manufacturers usually put out good stuff, and the reliable old trade names such as AC, Fram, and Purolator are hard to beat. PS

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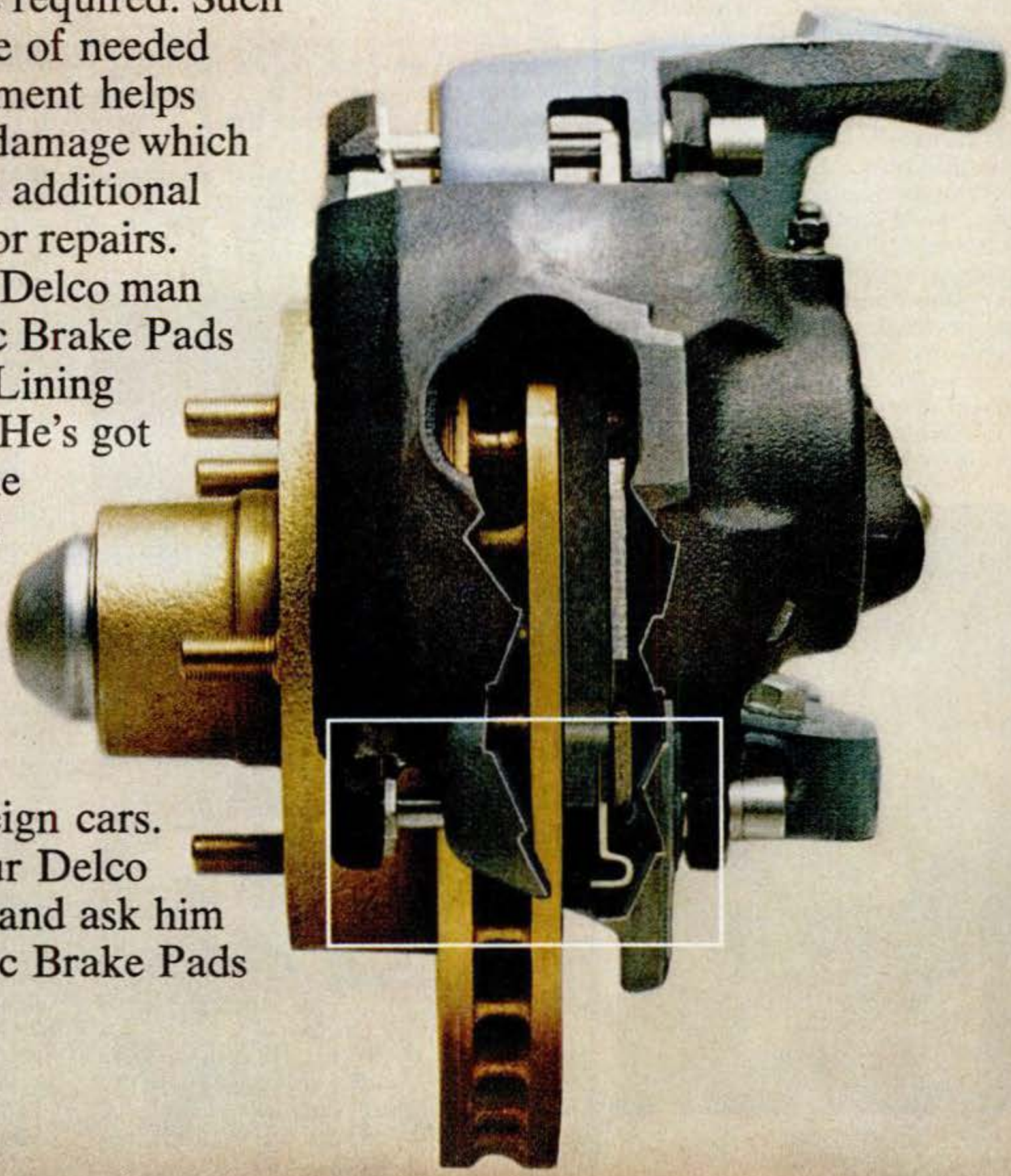
WHEN IT'S TIME FOR NEW DISC BRAKE PADS OURS WILL GIVE YOU A BUZZ.

Delco announces replacement Disc Brake Pads with a new Lining Wear Sensor for most GM Disc Brake-equipped cars. The Sensor is a built-in device designed to produce a high-pitched sound when lining replacement is required. Such advance notice of needed lining replacement helps prevent rotor damage which could result in additional replacements or repairs.

See your Delco man for Delco Disc Brake Pads with the new Lining Wear Sensor. He's got a complete line of Delco parts for both disc and drum brakes to fit all American-made cars and most foreign cars.

Give your Delco dealer a buzz and ask him about our Disc Brake Pads that buzz.

When the lining wears to a point where it needs replacement, the Sensor touches the rotor and creates a "Buzz".



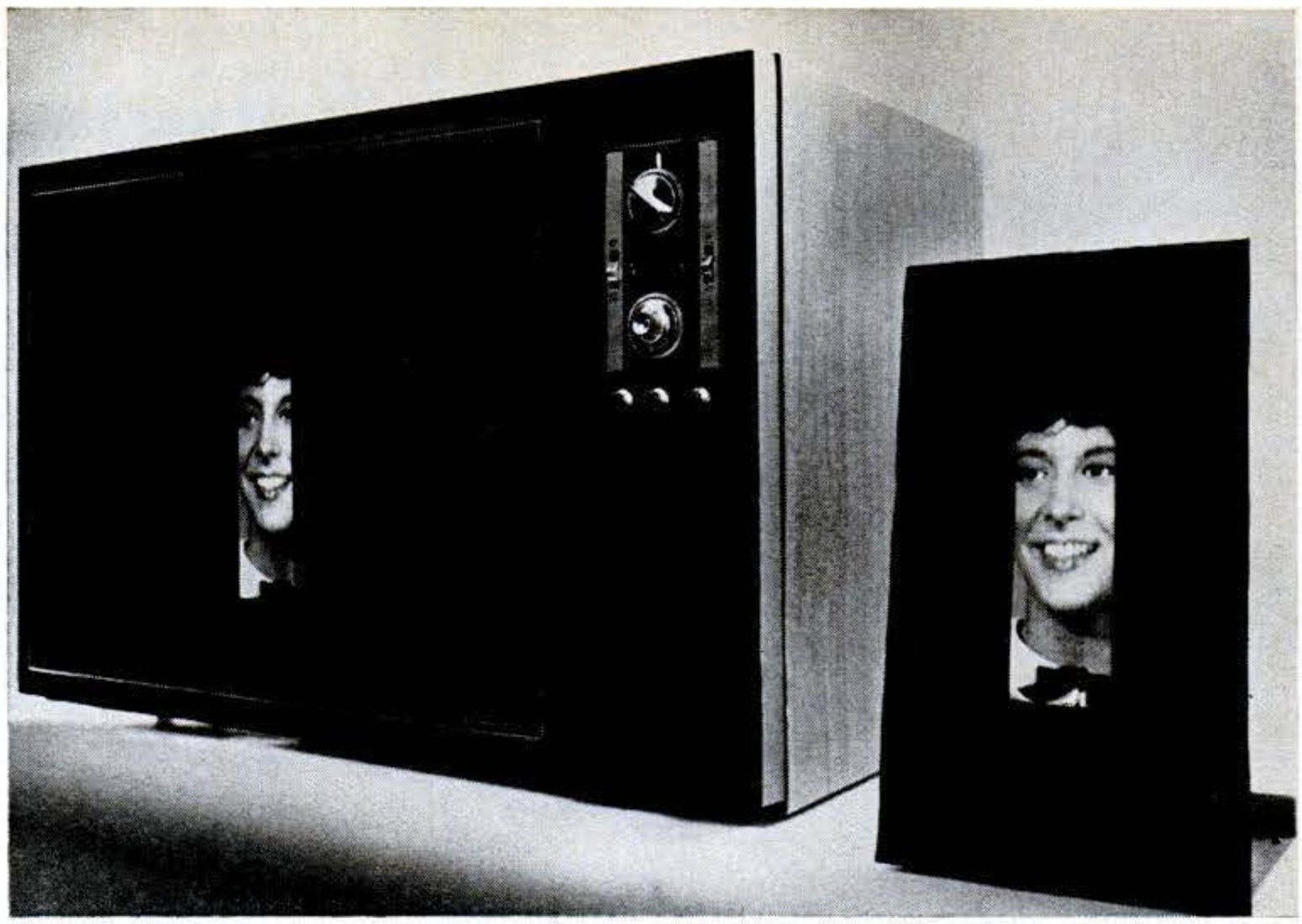
THE MORE YOU KNOW, THE MORE YOU'LL WANT DELCO.

Delco GM

Look and Listen

News, comment, and opinion from the world of home-entertainment electronics

By C. P. GILMORE

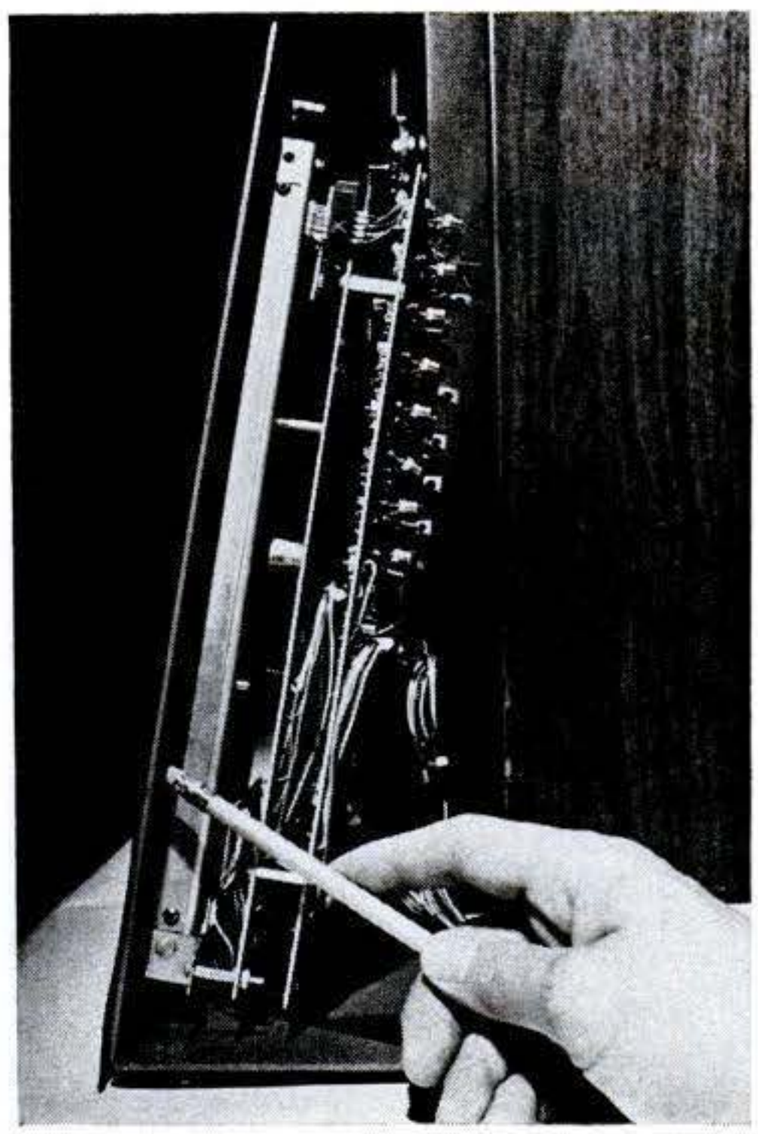


Flat-screen TV—really on the way?

The young lady in the picture below isn't peeking through a king-sized keyhole. Rather, the screen of the television set has been masked down to the same size as the display panel on the right. The purpose of the whole thing is to demonstrate that the picture at right, produced by a revolutionary flat-screen display just over ½-inch thick, is equal in resolution to a conventional color-TV picture.

Electronics research engineers have been working for years trying to design flat-screen hang-on-the-wall television. In the attempt, they've used incandescent lights, electroluminescent panels, liquid crystals, and other techniques. The new device, built by Zenith Radio, uses neon-gas discharge tubes. The closeup view of the screen shows the 16,960 pinhead-size gas-discharge tubes arranged in 80 columns and 212 rows, each one illuminated to just the right intensity to produce the overall picture. In principle an entire TV screen could be built this way, using an array of about a million gas tubes arranged in triads or triangular clusters in about 525 rows and columns. Unfortunately, such a rig would need tremendously complicated electronic circuitry, which in turn would require the development of new high-voltage integrated circuits. In addition, the research model produces only a red-orange picture since that is the normal color of glowing neon. A full-color picture would require three times as many bulbs with each triad containing one blue, one red, and one green light source.

The panel is startlingly thin, as the accompanying photo shows. That's it indicated by the pencil eraser. The gear in back of it is electronics; if there were any desire to make the display really picture-thin, the circuitry could be placed elsewhere. In an actual commercial model, it would be much more compact, using specially designed integrated circuits.



When will you find it in the corner TV store? Your guess is as good as mine. Zenith emphasizes that this is just a study model to see if it could be done on an experimental basis. Work will continue, but nobody knows when—or if—it will ever go into production.

Video from an audio cassette

The Matsushita Company—Panasonic is its best-known consumer-brand name—says it has designed a new video player that can record up to 1000 still color pictures plus stereo sound on an ordinary 60-minute audio cassette operating at the standard 1⅞-inch speed. It can't provide regular moving pictures, as can a video tape recorder, but does produce a new color image every 3.6 seconds. The new machine undoubtedly could find many uses in industry, the schools, and elsewhere. In addition, getting pictures out of that tiny cassette is something of a technical triumph.

The 30 best demo discs of '72 reviewed by Arthur Fisher

Here are an even 30 1972 recordings that show off your stereo rig to sensational effect—or perhaps reveal some painful defects. Some have been reviewed here before; most have not. All share a "state of the art" quality of recorded sound (although the recording techniques used may not necessarily result in musical realism or good taste). Not so incidentally, the performances are all first-rate. This selection is, of course, a highly subjective one; because excellent stereo sound engineering is commonplace (although flaw-free pressings, regrettably, are not), it represents only a small fraction of the discs that could have been included. My nomination for most-spectacular-sounding record of the year—and an amazing performance: London's Messiaen-Ives release with Stokowski.

The records are listed more or less in order of complexity of the sound they contain. Works for chorus and large orchestra make enormous demands on your sound equipment, with distortion a particular problem. Listen for the words of the chorus: If you hear them clearly, even in loud ensemble passages, your rig is a winner. Orchestral records let you listen for realistic reproduction of individual instruments, the clean sound of massed strings that means extended

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highs, the crisp percussion that means good transient response, and wide dynamic range. Stereo image can be judged critically by listening to "location" in small vocal and instrumental groups. The harpsichord—like other plucked instruments—makes an excellent test of transients and the high end. The Columbia two-harpsichord disc will really tell you how good your channel separation is. The piano? It's probably the most difficult single instrument to record naturally. And an organ recording will test for clean bass.

Finally, you can zap your speakers with rock or progressive jazz sound and just keep your fingers crossed.

A Mass of Life—Delius; soloists, London Philharmonic Choir and Orchestra conducted by Charles Grove. Angel.

Symphony No. 8 (Symphony of a Thousand)—Mahler; soloists, choirs, Bavarian Radio Symphony Orchestra conducted by Rafael Kubelik. Deutsche Grammophon.

Sacred Choral Music—Mozart; London Symphony Orchestra and Chorus conducted by Colin Davis. Philips.

Virtuoso Madrigals—Monteverdi; soloists, chorus, and instrumentalists, conducted by Jürgen Jürgens. Archive.

Alexander Nevsky—Prokofiev; London Symphony Orchestra and Chorus conducted by André Previn. Angel.

The White Birch Tree and Other Russian Songs—U.S.S.R. Russian Chorus (unaccompanied) conducted by Alexander Sveshnikov. Melodiya/Angel.

L'Ascension—Messiaen; *Second Orchestral Set*—Ives; London Symphony Orchestra and Chorus conducted by Leopold Stokowski. London.

The Planets—Holst; Los Angeles Philharmonic Orchestra conducted by Zubin Mehta. London.

Daphnis and Chloé, Suites 1 and 2; Ma Mère l'Oye—Ravel; Concertgebouw Orchestra conducted by Bernard Haitink. Philips.

Symphony No. 12—Shostakovitch; Gewandhaus Orchestra Leipzig conducted by Ogan Durjan. Philips.

Invitation to the Dance—Weber, Berlioz, Liszt, Smetana, Dvorak; Berlin Philharmonic conducted by Herbert von Karajan. Deutsche Grammophon.

The Rite of Spring—Stravinsky; Boston Symphony conducted by Michael Tilson Thomas. Deutsche Grammophon.

Petrushka—Stravinsky; N.Y. Philharmonic, Boulez conducting. Columbia.

The Miraculous Mandarin; Dance Suite—Bartok; N.Y. Philharmonic and Schola Cantorum conducted by Pierre Boulez. Columbia.

Tuba Concerto in F minor; Pastoral Symphony (No. 3)—Vaughan Williams; John Fletcher, tuba, London Symphony conducted by André Previn. RCA.

Triple Concerto—Beethoven; Claudio Arrau, piano, Henryk Szeryng, violin, Janos Starker, cello, New Philharmonia conducted by Eliahu Inbal. Philips.

Oboe Concertos—Mozart, R. Strauss; Heinz Holliger, oboe, New Philharmonia conducted by Edo de Waart. Philips.

Harpsichord Concerto—de Falla; Rafael Puyana, harpsichord, various instrumentalists, conducted by Charles Mackerras. Philips.

The Virtuoso Trumpet; Baroque Trumpet Anthology—both discs, various Baroque composers; Don Smithers, trumpet, various soloists (I Musici in the first). Philips.

Six Brandenburg Concertos—J. S. Bach; Anthony Newman "and friends." Columbia.

Duets with Spanish Guitar, Album 2—Villa-Lobos, Debussy, others; Laurindo Almeida, guitar, Salli Terri, singer, soloists on flute, clarinet, viola. Angel.

Music for Two Harpsichords—Handel, Mozart, others; Igor Kipnis, Thurston Dart, harpsichords. Columbia.

Harpsichord Music—Louis and Francois Couperin; Albert Fuller, harpsichord. Nonesuch.

Twenty-Three Sonatas—Scarlatti; Anthony di Bonaventura, piano. Connoisseur Society (two discs).

Liszt Piano Music (Sonata in B minor, others)—Claudio Arrau. Philips.

My Favorite Debussy—Van Cliburn. RCA.

Bach Organ Favorites, Vol. 5—E. Power Biggs, organ. Columbia.

Eagles (Witchy Woman, etc.)—Eagles. Asylum Records.

Miles Davis Live—Miles Davis, trumpet; others. Columbia (two discs).

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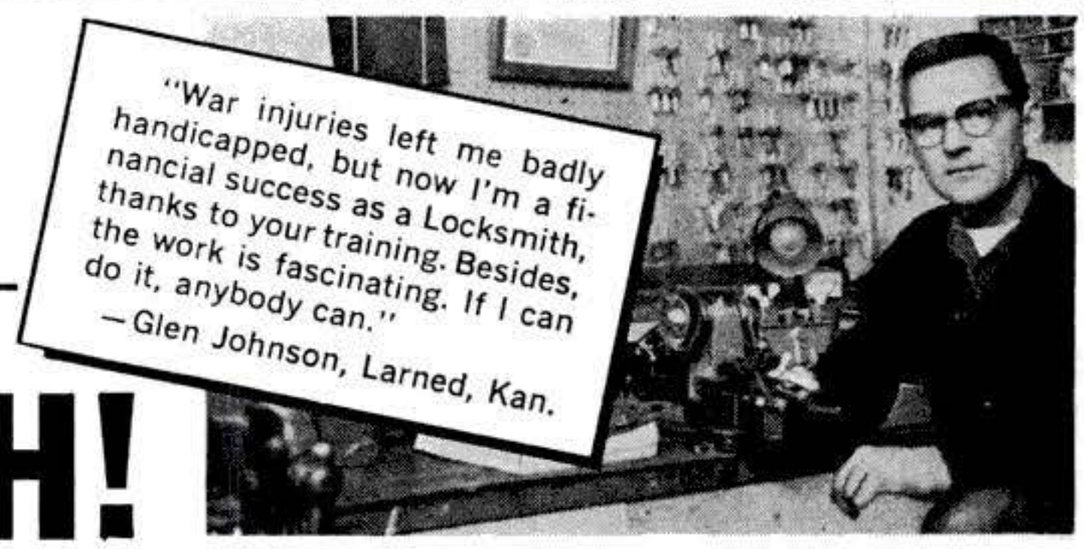

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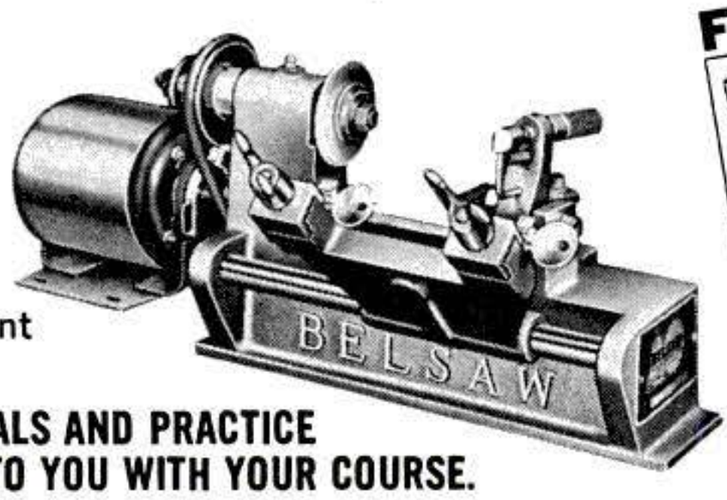

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PS Ratings—Report in a Nutshell

Look for changes in the Norbye/Dunne Report this month; the most important, a rating system. On page 62 you can read about how we worked it out and what the ratings show. They're *all based on facts:* test results or actual measurements. Opinions or subjective judgment play no part in scoring points. Five points is excellent; 4, very good; 3, good; 2, fair; 1, poor; 0, very poor.

	Chevelle	Torino	Matador	Satellite
Acceleration	3	4	4	3
Brakes	2	4	3	3
Handling	1	2	1	2
Maneuverability	4	2	2	1
Fuel economy	1	1	1	1
Quietness	2	3	1	1
Ride comfort	(4)	(3)	(4)	(3)
Roominess	4	4	4	4
Visibility	3	0	1	0
Entry/exit	3	2	2	3

POPULAR SCIENCE CAR TEST NORBYE/DUNNE REPORT

THE NEW INTERMEDIATES: Are They Better Than Last Year's?

How PS tests brakes—and what we learn from it

We test a car's ability to stop within a 12-foot-wide lane from 60 mph without front-wheel locking. Tests are made first with cool brakes to show brake capacity and balance. Next, we make 10 warmup stops from 60 mph (at one-minute intervals at 0.5-g deceleration). The test is repeated to show fade resistance. Above is the Ford Gran Torino Sport in the cool-brake test. Rear wheels locked at once, pulling the tail sideways. Power brakes reacted slowly to pumping, stretching rear-wheel skid. Still, it stopped in 140 feet. With hot brakes, rear wheels did not lock and the car stopped in an impressively short 134 feet. Results for the other cars appear on page 42. Ratings of all the cars in the PS test group (top of this page) let you make comparisons fast.

Performance and economy are worse, but you'll also find some improvements

By **JAN P. NORBYE** / *PS Auto Editor* and **JIM DUNNE** / *PS Detroit Editor*
PHOTOS BY A. J. HAND

For our first test of '73-model cars, we chose the top-line two-door intermediates from the best-selling makes. The reasons are simple:

- Intermediates are more popular than full-size cars.
- Two-door models outsell four-door models.
- The top model in each car line sells better than the lowest-priced.

Our test group is shown in the photo above. Top to bottom, they are the Ford Gran Torino Sport, Chevrolet Chevelle Laguna, Plymouth Satellite Sebring, and AMC Matador.

We tested '72 intermediates last January, and we are now able to make

Continued

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Come to where the flavor is.
Come to Marlboro Country.

ıings: 18 mg. "tar," 1.3 mg. nicotine—
000's: 19 mg. "tar," 1.5 mg. nicotine av. per cigarette, FTC Report Aug.'72

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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MEATS

Have you had a job interview lately where you really felt needed?

Let's face it. It's tough to get a good job without experience. And how much experience can you have fresh out of high school?

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We've got over 200 job-training courses to choose from. Construction, transportation, computers, you name it. If you're qualified, you'll get it. Guaranteed.

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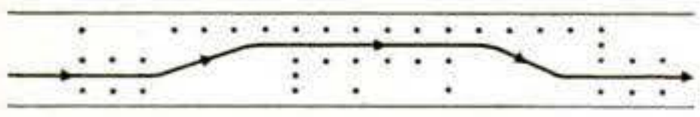
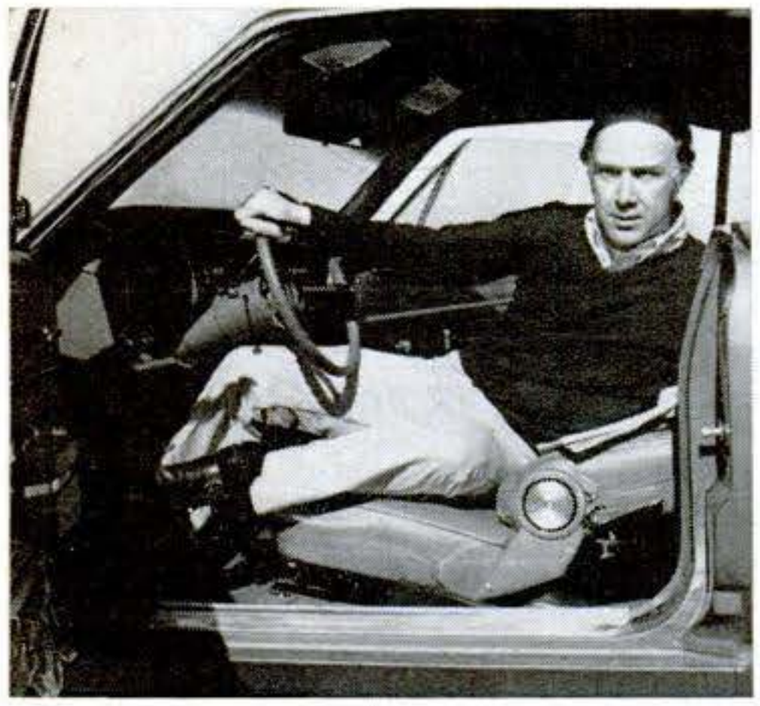
Standardized handling test simulates high-speed emergency swerve



Two lane changes in quick succession show evasive ability at high speed. Lanes 12 feet wide are blocked 120 feet apart; lane-change gaps are 60 feet long. Speed is increased in several runs until a car's limit is reached (timed by stopwatch).

Above, Chevelle shows left body roll, high slip angle on left front tire. This car was unable to average better than 53 mph due to delay between steering input and change of direction. It has excellent stability, reasonable initial response, but poor ability to cope with steering reversals at high speed. At this test point, a car should be free of side loads, ready to line up in the right lane. But Chevelle needs more time for each transient stage.

Ford was fastest (58.2 mph), aided by wider tires; Plymouth next (56.3 mph). Matador matched Chevelle's speed, but excessive understeer showed up as extreme slip angles on front tires. Rear wheels were just tracking behind. Chevelle had high slip angles on **all** tires, showing basically neutral steering characteristic. Gran Torino Sport had firm understeer but very good response. Satellite Sebring had very quick response, with initial understeer gradually lessening as side loads increased. It's balanced for safe, predictable handling.



Matador bucket seats recline fully; the mechanism now has no notches. Seat back tilts forward for access to the rear seat.

Swing bucket seats on Chevelle aid the fat, infirm, and elderly, but waste time for impatient young and agile drivers.

some telling comparisons, especially in the performance area. Due to the introduction of exhaust-gas recirculation systems (for control of nitrogen oxide emissions), acceleration is down and fuel consumption is up.

In other areas, the differences from last year's cars are more subtle. And we should point out that the '72 intermediates we tested are not fully comparable with this group, since they had four-door bodies. At that time, we expected more people to buy the four-door sedan, but they chose the lighter, shorter-wheelbase, two-door coupes.

Keep that in mind when you compare the results of the handling and maneuverability tests. More about those tests later. Brakes? Practically no change. But the industry deserves

Continued

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HOW COULD YOU FORGET

MILT MARION?

1936 was a very good year for a race fan. The very first race on the famous Daytona Beach-Road Course was held.

The purse was 5,000 bucks, and lest you think this was a minor-league affair, remember the price of groceries in '36. This kind of important money attracted a pretty hot field, including: the Indy 500 winner, Bill Cummings; the dirt track champions Bob Sall, Doc Mackenzie and Ben Shaw; Major Goldie Gardner; the Collier brothers, Miles and Sam; and an obscure service station operator named Bill France.

The winner? Good old boy Milt Marion, in a Ford V-8, the Permatex Special. (That France fellow was not only Milt's mechanic, but drove another Ford to fifth place.)

The interesting thing about Milt's car was that the engine was literally stuck together with Permatex products. To prove they worked, the engine was assembled without any gaskets, using our Form-A-Gasket products instead (Form-A-Gasket #1, hard-setting, and Form-A-Gasket #2, pliable-setting). Obviously, it held together.

It really wasn't much of a gamble for Permatex. After all, the company got its start helping Barney Oldfield, back in '09. And today, you'll find Permatex products in service stations, NASCAR garages, and wherever automotive products are sold.

You'll find the same Form-A-Gasket that helped Barney and Milt. And you'll find the latest additions to our long line. Like the new Silicone Form-A-Gasket. With this handy tube, you can actually *make* any size or shape gasket for any application. And being silicone rubber, it is resistant to a greater variety of chemicals, higher pressures, and higher and lower temperatures than anything else you can buy. It is the most versatile adhesive-sealant there is.

Want a free racing decal? You can have one if you promise to remember Milt. Just send us a self-addressed stamped envelope. Don't forget.

Permatex®
our name is our bond

PERMATEX COMPANY, INC.
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Courtesy of Museum of Speed, Daytona Beach, Florida

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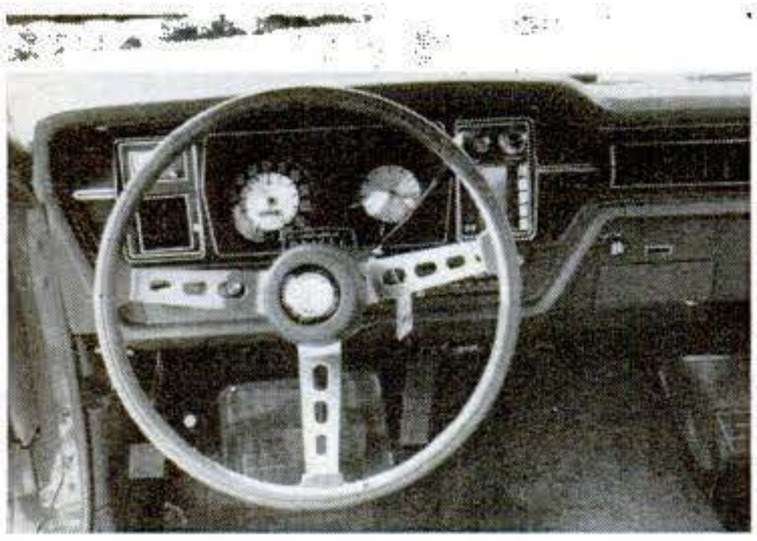
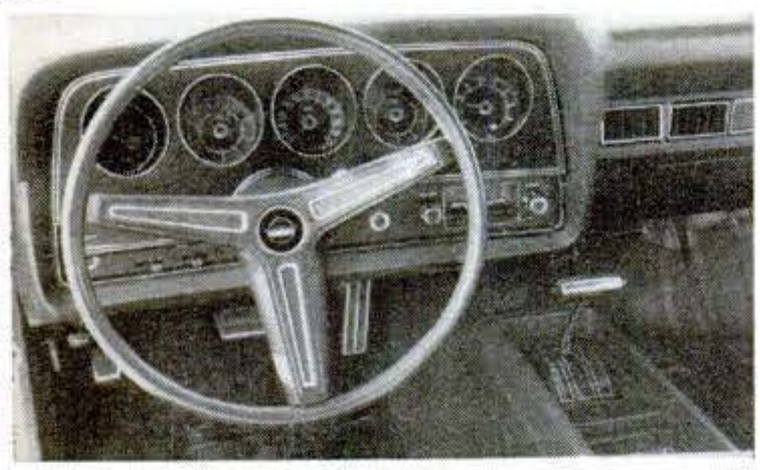
praise for the enormous improvements in brake systems that have been achieved over a five-year period. Five years ago it was exceptional to find a car that would stop from 60 mph with warmed-up brakes in less than 160 feet, and many took close to 200. The average for these four '73 intermediates is 159.3 feet, and the average for the '72 intermediate sedans was a bit more: 161.77 feet.

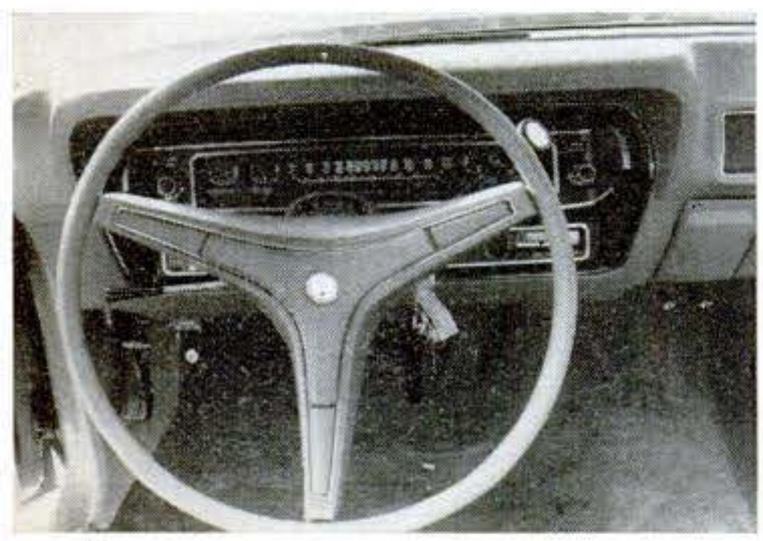


Matador instrument cluster includes a radio, but a minimum of gauges. You rely on warning lights for all malfunctions.

Chevelle instrumentation is unusually complete, and small controls are ideally placed. Test car had optional tilt-wheel.



Only car with console shift (and no eye-level PRNDL-indicator) was the Gran Torino Sport. Its instrumentation is fine.



Satellite was singular for non-circular speedometer. A full set of gauges is deeply recessed in the instrument cluster.

It's not difficult to understand why the intermediate coupe has replaced the full-size sedan as the best-seller. These cars make a lot of sense. They have smaller overall dimensions and lower prices than the "standard" cars. They have roomy and practical interiors, and there is no lack of niceties you find in the bigger cars—virtually the same luxury options, the same big-car ride comfort, and quiet interiors.

All auto makers also offer a full lineup of standard and optional engines, so you can order the car of your choice with the power team that best fits your specific requirements.

We chose the small V8s for this group. They are standard in some cases, and by far the most popular choice for intermediates. You may be surprised to see the disparity in engine displacement—they range from 318 cubic inches in the Satellite to 400 in the Gran Torino.

Yet the acceleration figures prove that we picked the right power units. The figures are closely matched, and the car with the largest engine was not the fastest in all tests! All four cars were also closely matched in gas mileage.

None of the cars had any serious drivability problems, though there were annoyances in this department. The Matador engine tended to run unevenly under part-throttle acceleration, the Chevelle could not pull under load unless warmed up for a full minute, and the Ford had delayed throttle response. Only the Satellite seemed to be entirely free of drivability complaints.

All were equipped with automatic transmissions (less than four percent of new intermediates are built with manual gearboxes). All transmissions are three-speed planetary units with hydraulic torque converters. The Satellite and Matador use Chrysler's excellent TorqueFlite. Ford calls its unit Selectshift Cruise-O-Matic, and the Chevelle comes equipped with the GM Turbo-Hydramatic.

We also specified power-assisted front disk brakes (standard on the Satellite) and power steering. Front disks without power assist are standard on Chevelle and Torino, while the standard brakes for the Matador have drums on all four wheels. This must count as a big plus for the Plymouth, and a small plus for the Ford and Chevy, since you (a) get better brakes to start with, and (b) pay less to get power disks.

Chevelle Laguna is the newest. The body and chassis are brand-new for '73. Before testing the car, we knew we liked the changes [PS, Oct. '72], particularly the improved visibility, the five-mph front bumper system, the new instrument panel, and the roof design with strong supports to offer better rollover protection.

In the ratings, the Laguna proved itself far ahead of its rivals in visibility. We rated it low on handling, and that's explained in a photo caption. Yet the car was superb in maneuverability—that story is in the box covering the subject.

The Laguna scored 2 points for braking. What was wrong? Mainly poor fade resistance. Pedal pressure went up from 20 pounds to 80 during the 10 warmup stops, and although the brakes gave better than 1g deceleration when cool, could do no better than 0.85g after warmup. We experienced an odd side pull to the right—easily overcome by steering left, but odd because disk brakes are usually free of side pull. We traced it to faulty front-wheel alignment.

The windshield antenna is tamperproof but doesn't give you the best reception. The glove box is small, and is located at the low end of the panel, but there is a neat little storage shelf on the left side to make up for that.

Fixed rear side windows could cause fogging, and block ventilation for back-seat riders. The doors are extremely wide and pose a problem in tight parking spaces. Curved door glass and sharp tumblehome can cause some people to hit their heads against the windows when getting out of the car, especially if there isn't room to swing the door wide open.

The Chevelle has a deep, wide trunk, but high liftover, and the spare wheel steals a lot of space. Service accessibility is average. There are no special problems, but not all points requiring periodic maintenance are easily reached. The side-terminal Delco battery is claimed to be corrosion-free; we don't keep our test cars long enough to check that.

Ford Gran Torino Sport. This all-new-for-'72 car has undergone practically no change for '73 (except to meet the bumper and emission-control standards). Compared with the '72 Gran Torino sedan we tested, the '73 coupe was faster—mainly due to its bigger engine (the sedan had a 351-cubic-inch V8).

Credit must be given to the wider tires for improvements in both braking and handling. The Ford was superior to its rivals in both brake and handling tests (while last year the Matador was best).

The Gran Torino Sport also proved to have the lowest (best) noise levels under all conditions. But it scored very low on visibility. The fastback roof is a serious drawback, and the

Continued

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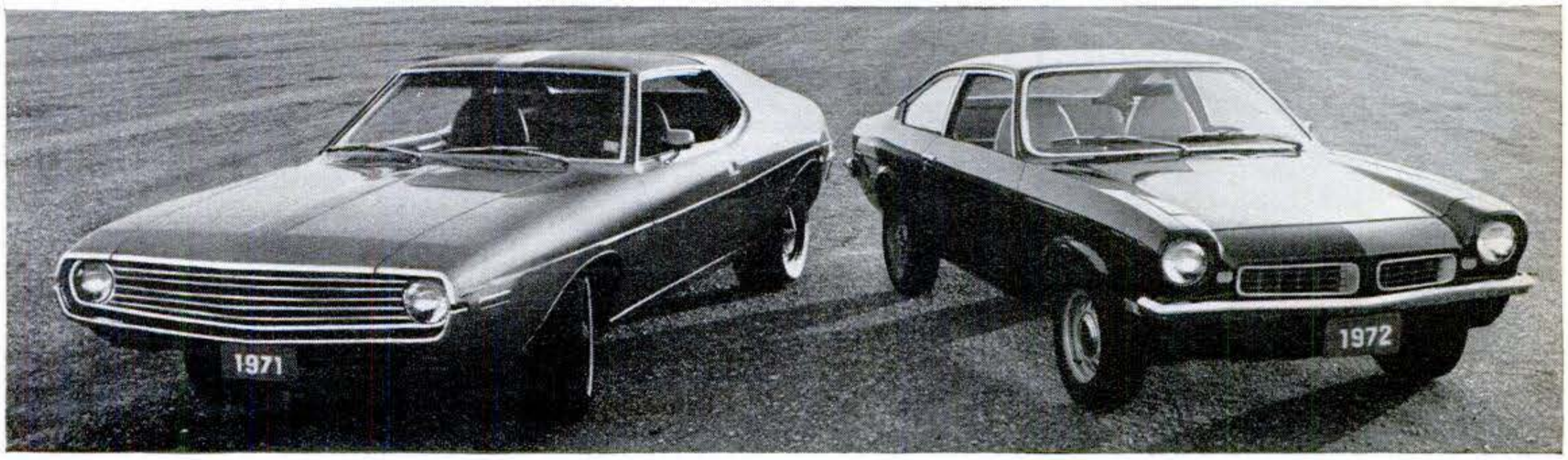
High compression. Low compression. Which is tougher on your oil?

Using high octane fuel, high compression engines generate high heat. Low compression engines using low octane and leaner fuel mixtures can run even hotter. And heat is the main reason motor oil deteriorates. Today you have to name your oil. By type. By SAE Grade. By brand.



Recent governmental regulations aimed at controlling automotive emissions have resulted in the introduction of low lead fuels. These fuels, in turn, are made necessary by the advent of new catalytic reactors soon to be required on all cars. For these reasons, car makers have had to reduce the compression ratios of the new car engines. Here's why.

Refresher course on compression ratio. A high compression ratio (10.5:1 is typical) needs high octane gasoline, and a rich mixture of gas-to-air for good driveability. That way you get top performance... but a lot of unburned gasses are passed through the tailpipe into the environment.

A low compression ratio (9:1, for instance) can operate on lower octane gas and a leaner mixture of fuel that's compatible with emissions control systems. The results are more sedate performance and greatly reduced pollution. Plus one more thing: heat. Oil-killing heat.

How heat kills oil. As you know, oil gets thin when hot. But did you also know that oil can *thicken* under heat? The cause is oxidation. That is, oxygen molecules combine with "oil" molecules to make more complex molecules. Under high heat conditions over extended periods, the oil can become dangerously thick. In extreme cases, it can become almost jelly.

A thickened, oxidized oil loses its ability to flow easily through the

engine. That causes metal-to-metal contacts. And vital parts wear more and more. In severe cases they seize.

Two ways to fight back.

1. Change oil more frequently

Because you can't judge when oil oxidation has reached the danger point, your best protection is to change oil more frequently. Your owner's manual gives you recommendations for normal conditions. But please read the little notes of caution that usually accompany the recommendation. Dusty roads, stop-and-go driving, sustained high-speed driving, heavy loads, extreme temperatures are all conditions requiring more frequent changes. Also be sure you choose the right SAE Grade for your driving climate.

2. Know your motor oils.

Today you have to be specific about motor oil. You should use one that is refined from the best grade of crude oil—then scientifically blended, fortified and proven. There's too much at stake to put just any motor oil into your crankcase.

You should also know that "SE" is a designation for motor oil which meets the requirements for high temperature engine performance and is recognized by the Automotive and Petroleum Industries. We advise that *all* fully equipped cars use it.

Why Quaker State offers quality protection. There's one thing about Quaker State Motor Oil that few others offer. 100% Pure Pennsylvania Grade Crude Oil. The world's choicest.

Then Quaker State Motor Oil is fortified with a blend of additives, so you can be sure that it will keep its cleaning and lubricating powers even when the going is hottest.

Remember. Ask for this fine motor oil by name wherever they care about cars. Quaker State.

Quaker State your car to keep it running young.

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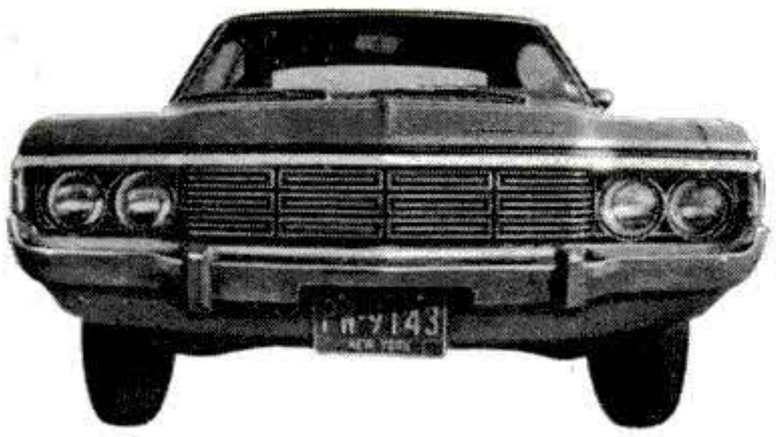
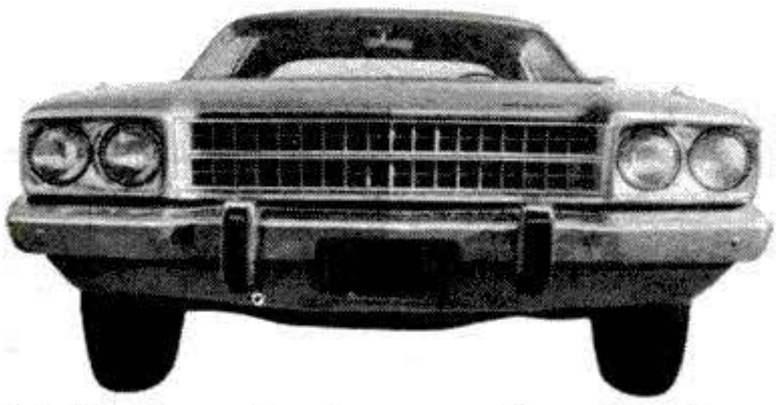


Matador bumper overriders extend downward only, giving incomplete protection. Turn signals are outboard of headlights.

Chevelle grille surround is plastic and forms part of the bumper structure. Turn signals are located inside the grille.



Satellite turn signals are positioned in the lower corners of the grille. Bumper overriders are hollow rubber cushions.

Torino bumper is massive, but overriders don't extend upward. Turn-signal lamps are placed inside the grille design.

high belt line further impedes the driver's view to the right rear. A long hood in combination with a low driver's seat obstructs the front view.

The Torino also scored low on ease of entry and exit. Access to the rear is a problem, and its back seat has the least room. Ventilation is assured through four face-high outlets on the instrument panel (no cowl inlets). The glove box is small, however, and awkwardly positioned underneath the instrument panel.

Under the hood, all normal service points are easily reached. Since the '72 redesign of the Torino, there are no spring towers crowding the engine, and plug change is now relatively easy. The trunk is very spacious, but much valuable room is taken up by the spare wheel, lying flat in the middle of the floor.

American Motors' Matador. You'll find it basically the same as the 1970-72 models, and mechanically identical with the Ambassador from the windshield rearward. Not radically styled when new, it's barely contemporary today. But it's a very practical car, providing a high level of passenger comfort, plenty of useful space, first-rate engineering and quality. American Motors builds some of the most advanced engines in the industry, and the Matador beat its rivals in acceleration from standstill.

The 0-60-mph test shows a car's ability to reach cruising speed from a stop sign. A 0-80-mph test shows its high-speed power reserve. We also make a 25-70-mph acceleration test to simulate a highway merging situation. All acceleration tests are made with the transmission selector in DRIVE. The 25-70-mph test will penalize a car that fails to kick down into low range.

All the cars in this group functioned impeccably (and the Ford beat the Matador by one-tenth of a second).

The Matador scored poorly on quietness. The AMC's unit-construction bodies have never been noted for quietness, and this test shows lack of improvement in an area that is getting more and more emphasis at GM, Ford, and Chrysler Corp. Matador brakes (supplied by Bendix) were very effective and were highly fade-resistant.

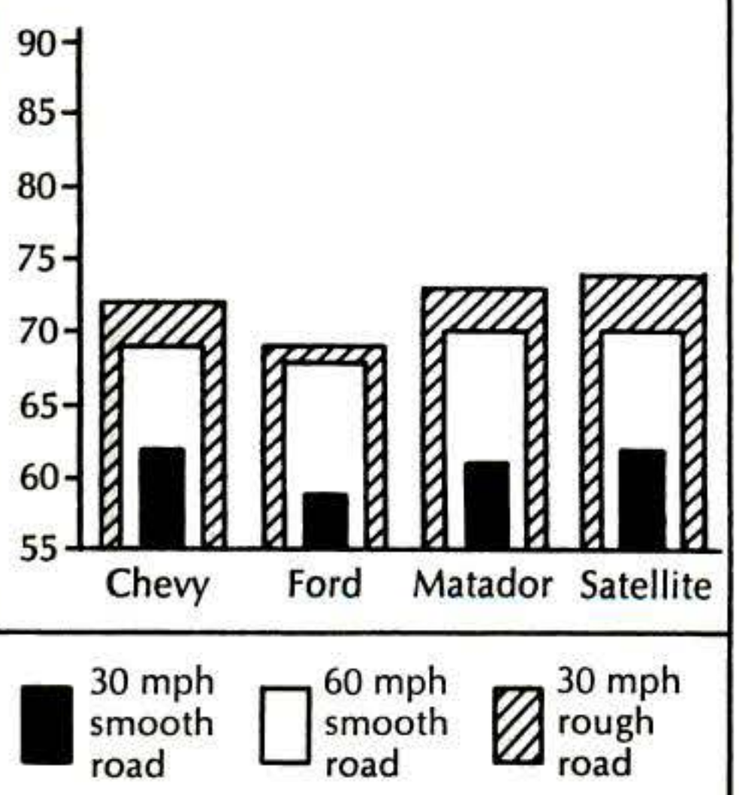
In the handling test, the Matador failed to equal the speed of the '72-model four-door Matador, but that could be due to different tires. (Note: tire pressures are checked prior to testing, and manufacturers' recommendations are followed.)

The Matador has the most generous back-seat dimensions, since two-door models are built with the same wheelbase as four-door sedans. It did not score particularly well for

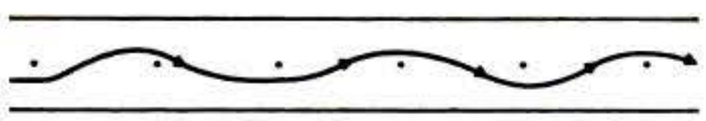
Continued

NOISE-LEVEL TESTS

We measure interior noise in decibels under three sets of conditions, on three different scales. For quick reading of the results, we give you only the A-weighted scale, which is most like human hearing in overall sound pickup. A decibel difference of one or two points is perceptible to a driver; five points make enormous difference.



PS maneuverability test—and why it's important



Simulating a low-speed emergency swerve—snaking the car as fast as possible through pylons 48 feet apart—tests maneuverability. It's a severe test of the steering system.

We time with a hand-held stopwatch. Each car goes through the test several times until its limit is reached. Fastest was Chevelle. It was perfectly balanced for sharp low-speed turns, aided by variable-ratio steering.

A low steering ratio ("quick" steering) is vital, since front wheels are turned to very wide steering angles, first one way, then the other. Cars with steering systems that give the lowest number of turns lock to lock have a test advantage; also cars with a short turn diameter. But the test takes account of the car's balance, too. Understeer is bad for maneuverability, but mild oversteer is tolerable. Cars with neutral handling characteristics have proved fastest.

The Satellite was the slowest, due entirely to pump catch in the power steering. On fast steering reversals, the valves in the power-steering unit can't keep up with commands from the steering wheel, and for a critical moment the whole steering system locks itself practically solid. When steering control is regained, the Satellite is either off course or has lost speed.

The Matador was 1.8 mph faster than the Satellite, 1.4 mph slower than the Chevelle. AM uses GM Saginaw power steering, but a different variable-ratio steering gear. That explains part of the speed difference. The rest is balance. The Matador's understeer was the limiting factor, as in the high-speed handling test. Front-tire slip angles build up until the car is just "plowing" and not making the intended turn.

The Torino matched the Matador's speed in our maneuverability test, but could go no faster due to Ford's choice of steering ratio (nonvariable, giving four turns lock-to-lock).

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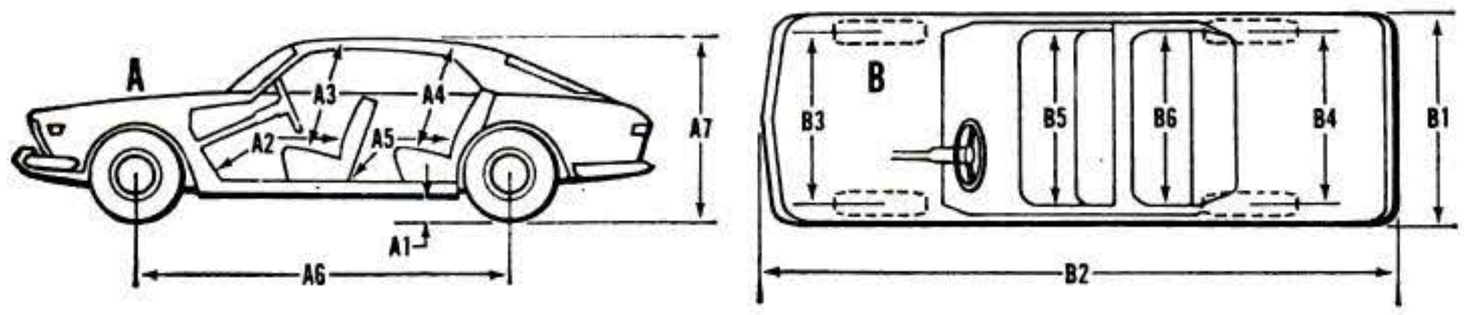
ease of entry and exit, but is rated better for visibility than either the Ford or the Plymouth.

It's the only car in the group that's equipped with those good old-fashioned vent windows in the front doors. It also has cowl vents on both sides in addition to four outlets spaced across the instrument panel. It has ample glove-box capacity, and a large ashtray. The hood release is placed in the middle of the car, safely away from the parking-brake release on the extreme left. On the other cars, the two can be confused, especially at night. There are assist straps over the doors, and extra storage pockets in the door panels.

The Matador also has the largest and most usable trunk, with the spare wheel placed forward over the axle, out of the way. Under-hood accessibility is uniformly good to all maintenance points.



	CHEVROLET Chevelle Laguna	FORD Gran Torino Sport	AMC Matador	PLYMOUTH Satellite Sebring
DIMENSIONS (inches)				
A1 Ground clearance	5.1	5.8	6.0	5.1
A2 Front leg room (max.)	42.2	41.9	41.8	41.9
A3 Front head room	37.7	37.3	38.95	37.3
A4 Rear head room	37.0	35.9	36.6	36.4
A5 Rear leg room (min.)	33.7	33.0	35.5	34.1
A6 Wheelbase	112.0	114.0	118.0	115.0
A7 Height	53.1	52.13	54.33	52.2
B1 Width	76.6	79.3	77.22	79.1
B2 Length	202.9	208.0	208.48	210.8
B3 Front track	61.5	62.8	60.0	62.0
B4 Rear track	60.7	62.9	60.0	62.0
B5 Front hip room	56.0	56.7	60.3	58.0
SPECIFICATIONS				
Engine type	OHV V8	OHV V8	OHV V8	OHV V8
Displacement (cu. in./cc)	350/5738	400/6557	360/5902	318/5213
Compression ratio	8.5:1	8.0:1	8.5:1	8.6:1
Carburetion	One 2-bbl.	One 2-bbl.	One 2-bbl.	One 2-bbl.
Net hp @ rpm	145 @ 4000	168 @ 3800	175 @ 4000	150 @ 3600
Net torque @ rpm	255 @ 2400	310 @ 2000	285 @ 2400	265 @ 2000
Transmission	Automatic	Automatic	Automatic	Automatic
Axle ratio	3.08:1	2.75:1	3.15:1	2.71:1
Tire make	Uniroyal	Firestone	Goodyear	Goodyear
Tire type	Fastrak Belted	Sup-R-Belt	Custom Power Cushion	Custom Power Cushion
Tire size	G78-14	G70-14	F78-14	H78-14
Steering	Power	Power	Power	Power
Overall ratio	17.9-13.0:1	21.73:1	19.4-15.7:1	18.82:1
Turns (lock to lock)	3.25	4.0	3.5	3.5
Turn diameter	39.6	41.0	39.0	41.2
Brake system	Power	Power	Power	Power
Type	Disk/drum	Disk/drum	Disk/drum	Disk/drum
Disk diameter	11.0	10.72	10.91	10.84
Drum diameter	9.5	10.0	10.0	10.0
Swept area	337.3	361.0	375.32	365.2
Fuel tank (gal.)	22.0	22.5	19.5	19.5
Trunk space (cu. ft.)	15.3	16.0	18.2	14.3
Liftover height	22.0	29.5	29.1	27.2
Curb weight (lbs.)	3963	4175	3805	3640
F/R weight distribution	56.9/43.1	57.7/42.3	55.4/44.6	54.9/45.1
Price (basic)	$2991	$3094	$3016	$3011
Price (as tested)	$3924	$4126	$3681	$3489
TEST RESULTS				
Acceleration 0-60 mph	13.15	11.8	11.5	13.1
Acceleration 0-80 mph	22.6	21.55	21.0	23.95
Acceleration 25-70 mph	14.15	12.65	12.75	14.2
Braking (cool) 60-0 mph	145.4 ft.	140 ft.	149 ft.	134.7 ft.
Pedal pressure	170 lbs.	55 lbs.	85 lbs.	70 lbs.
Braking (hot) 60-0 mph	186.9 ft.	134 ft.	160.1 ft.	156.2 ft.
Pedal pressure	200+ lbs.	110 lbs.	45 lbs.	200+ lbs.
Handling test (mph)	53.0	58.2	53.0	56.3
Maneuverability test (mph)	25.3	23.9	23.9	22.1
Gas mileage (constant 45 mph)	14.494	14.713	14.316	15.167

TEST CONDITIONS: Ambient temperature ..... 63° F
Humidity 44%
Barometric pressure ..... 30.9 inches

Plymouth Satellite Sebring. It's an updated version of the Chrysler Corp. intermediate series that was all-new in 1971. It is fully up-to-date in appearance, and the engineering is ahead of the competition in several ways.

First, electronic ignition is standard. You save money on tune-ups and get extra reliability. Change plugs every 18,000 miles, and never worry about points or condenser (they've been eliminated).

Second, the 318-cubic-inch V8—not a new design by any means—gets better with age. It gave better gas mileage than its rivals, yet proved fully competitive on acceleration.

The car's handling and maneuverability are discussed in a caption and in one of the boxes up front. Brakes? Excessive fade—pedal pressure more than doubled during the warmup stops. But stopping distances remained short, and we gave the Satellite a 3-point rating for brakes.

Rear-seat room is almost as good as the Matador's, though the seat is lower and you have to bend your knees more. Entry and exit are easier than in the Matador, and the pushbutton seat-back lock is the easiest type to use. Ventilation is positive, but the car has no high-level outlets. In this group, this was the noisiest car. You have to pay extra for a "sound package" and that could well be worth the price.

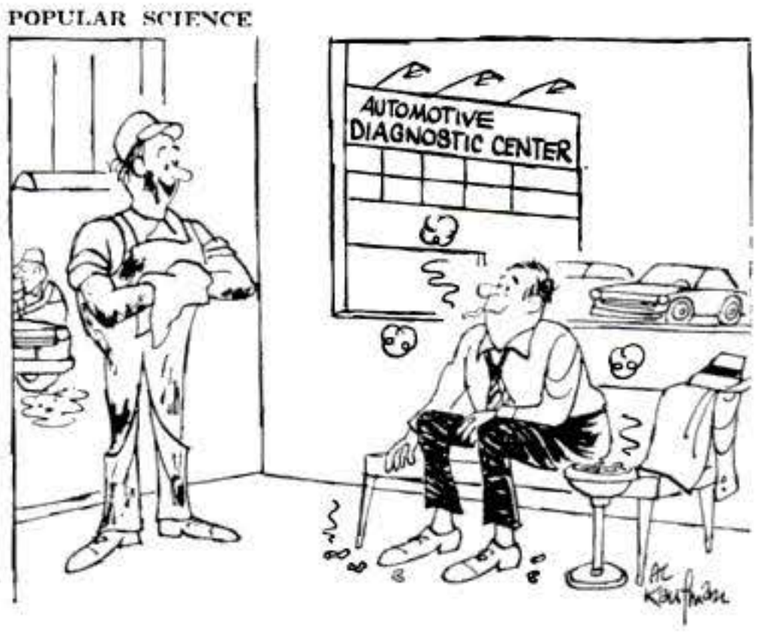
Visibility is just slightly better than that provided for the Torino. The Satellite has a large trunk, with a reasonable liftover height.

Spark plugs are located above the exhaust manifold—easy to get at. Even the oil filter is easy to change.

Many Plymouths we have tested in the past have suffered from fuel starvation during hard cornering. That means a sudden loss of power in the middle of a curve. That problem has been licked with the 318 V8 in the Satellite. We ran it for several "hot" laps at Bridgehampton and the fuel supply remained as steady as when cruising on the Expressway. PS

How other cars have fared in our tests

TESTS	'72 CHEVELLE	'72 GRAN TORINO	'72 MATADOR	'72 SATELLITE	MERCEDES 250	CITROEN DS 21	BUICK LE SABRE	CHRYSLER NEWPORT	MERCURY MONTEREY	OLDSMOBILE DELTA 88	VOLVO 144S	AUDI 100LS
Accel. 0-60	11.4	14.3	10.3	12.6	14.05	18.2	11.0	10.35	11.35	9.65	14.2	13.4
Accel. 0-80	20.45	27.6	20.4	22.55	23.75	32.4	20.5	18.75	22.4	15.8	28.3	24.1
Accel. 25-70	11.75	15.65	12.05	14.25	15.1	18.6	12.05	11.3	13.25	10.1	14.7	15.0
Brakes 60-0 (hot)	180.6	173.3	141.9	151.3	126.5	146.3	183.2	175.2	183.5	154.2	142.9	155.0
Handling (mph)	54.5	53.0	56.3	53.0	60.0	60.0	54.5	51.3	49.9	53.0	51.45	54.6
Maneuver. (mph)	23.9	21.8	24.6	25.3	28.6	28.1	22.4	22.4	21.8	22.7	24.4	26.4
Fuel (mpg 45 mph)	15.45	17.36	18.78	15.96	12.82	26.57	12.25	11.62	10.54	12.51	19.6	17.4
Noise (60 mph)	70dbA	70dbA	73dbA	73dbA	74dbA	73dbA	68dbA	69dbA	69dbA	67dbA	78dbA	76dbA
Price	$4094	$4308	$3790	$4255	$7221	$5561	$5788	$5315	$4812	$5231	$3620	$3945



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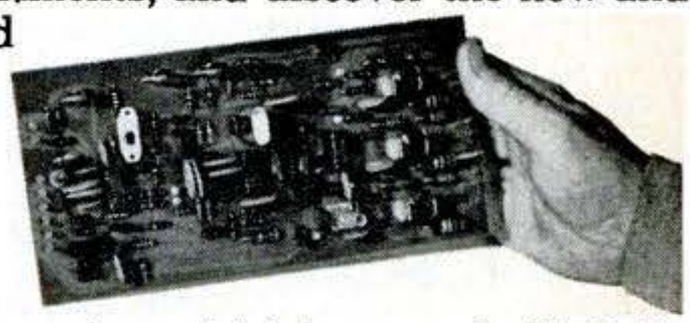

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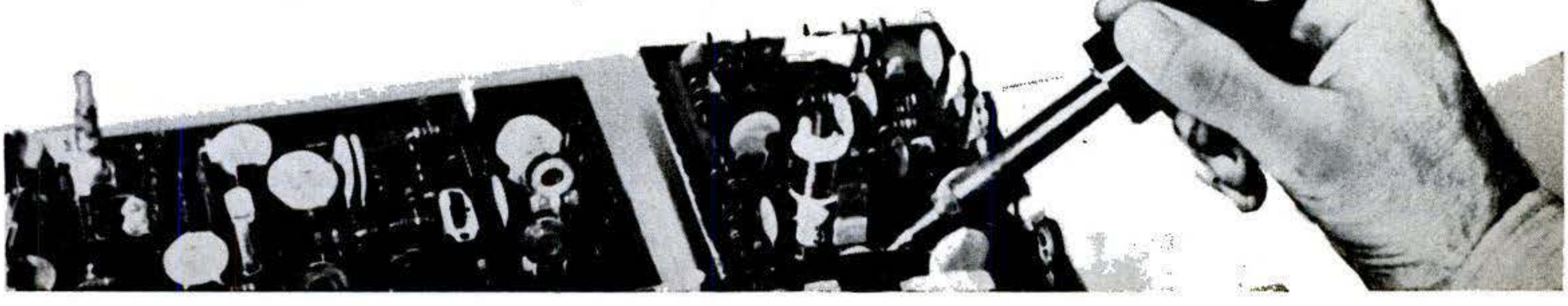

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Detroit Report...

By JIM DUNNE / *PS Detroit Editor*

Finally—a U.S.-built subcompact car from Chrysler

The Chrysler Corp. is planning an all-new model to compete with Pinto, Vega, and Gremlin; but not until late 1976. The type of engine—rotary or reciprocating—is still undecided. Whatever the decision, Chrysler will have to invest millions in new production equipment since the smallest power plant it now makes—the 225-cu.-in. slant six—is too large to fit under the hood. Unlike earlier plans for such a car, the present program calls for an all-new body shell, not a cut-down Valiant. The delay in the power-plant decision has held up the program: transmission, suspension, emission-control equipment, and size of under-hood compartment, all depend on Chrysler's ultimate choice. Right now they're leaning toward the piston engine.

VW's farewell to the rear engine?

Volkswagen will soon jump in with a special model for small-car fans. The German company plans to build a small front-wheel-drive car of about the Beetle's size, within three years. Code-named the "337," the car will have a water-cooled, four-cylinder engine of 55 base horsepower. Engine displacement will range from 1300cc to 2000cc, depending on the model. Reports say that the plan is to offer the new line side-by-side with the Beetle for a few years, then phase out the least popular car. That could take another 10 years, so don't interpret this as the end of the venerable Beetle.

What will Buick do about the Opel?

Following weak sales in '72, Opel faces a further drop in sales when Buick introduces its new Apollo compact model next month. The last few years have seen the bottom drop out of the Opel program in the U.S. Only five years ago, Opels were second only to VWs in import sales. Today they are fifth, and sliding. The new Apollo line, while not competing directly with the Opels, will be priced close enough to drain off even more sales.

The Apollo is built on the GM "X" body, and shares most of its components with the Nova, Ventura, and Omega. But it will have its own hood, front-end panel, grille, head-lamp doors, and taillights for identification purposes. Three engines will be offered: the Chevrolet 250-cu.-in. six, and two versions of Buick's own 350-cu.-in. V8.

Emissions—the big question

After protesting for years that the 1975-1976 emission standards are too tough to be met, the auto industry has shifted its stance. Now, Detroit is beginning to question whether we gain anything by cleaning the air to the extent specified for '76. Chrysler president John Riccardo has called for a suspension of the '75-'76 standards "because they are not necessary to protect the public health." Riccardo claims that the auto industry has already "basically solved the problem of automotive air pollution."

But General Motors is planning to meet the '76 standards, and its emission-control system is now undergoing a fleet test in California. It includes supplementary air injection, an exhaust-manifold reactor, a catalytic converter, a new type of carburetor, and a series of valves that shunt the exhaust gases for recirculation depending on their need for cleaning. No cost figures have been released yet.

Federal control at limit?

It begins to seem very likely that your car five years from now will have all the major controls that the government plans to require:

You'll be able to slam into another car at 10 mph without damage.

The car's interior will act as a protective cocoon in 50-mph crashes.

The exhaust will be "almost clean enough to breathe," as one Ford executive describes it.

Additional controls over lighting, vision, tires, and brakes on cars of the future will not cause the reaction in the industry that resulted when recent standards on safety and emissions were announced.

No chance for a Wankel-powered VW

Though Volkswagen Werk owns 90 percent of NSU, which owns the rights to the Wankel engine, VW has no plans to put a rotary in the Beetle. VW of America president Stuart Perkins says the rotary is just too expensive an engine to build for an economy car like the Beetle. "It costs about 50 percent more to manufacture, and we don't want to add that cost to the Beetle," Perkins told me. VW evidently wants to keep down the car's basic price, and not make any major investments from now on. But Perkins, also head of Audi in the U.S., was not as positive that the engine couldn't find its way into a bigger car built by VW. Since Audis run down the same assembly line as the Ro-80, it seems only a matter of time before they get the revolutionary engine.

More on the Wankel-powered Vega

Chevrolet will be able to build as many rotary-engine-powered Vegas as demand calls for when the GMRE models come out in 1974. Although the company has not released any figures, the fact that the GMRE would be offered as an optional power plant on the Vega at substantial extra cost was seen as part of a plan to keep sales below the 50,000-per-year level. But now it appears that Chevy will have the capability of producing enough GMREs to equip every Vega they build with the rotary engine—as many as 500,000 per year, depending on overtime and multiple work-shift schedules. The first engines will be built at Hydra-Matic, but Chevrolet is planning to open a new GMRE line at one of its own plants, probably in Tonowanda. This will double the output, so there will be no lack of rotary engines for GM cars.

Ford looks at steam power

Ford is leaving no stone unturned in investigating the benefits of alternate automotive power sources. The company is developing turbine, rotary, Stirling, electric, and steam engines, and testing innovations in piston engines. Furthest along is the turbine. But this engine is too big for automobiles. Newest experiment is with a steam engine built by Thermo-Electron, Ford's partner in vapor-engine research. Ford is "encouraged" so far by the project—underway since 1968. But insiders are skeptical. They see the steam engine as outdated, and far behind the Wankel and turbine as an automobile power plant.

There's a new van coming

Ford is preparing a new van-type vehicle that will replace the Econoline within 18 months. The freshly styled van is code-named "Nantucket." Front sheet metal will angle forward from the top and bottom to form a definite peak line running horizontally across the width of the vehicle between windshield bottom and bumper. This will eliminate the drabness of the flat front. You will also see bigger engines and wider choice of options when the new model is introduced in '74.

Hardtops follow the convertible

Next year, GM will begin to phase out the hardtop models on its B- and C-body cars—the big Chevys, Buicks, Cadillacs, Olds, and Pontiacs. For 1974, the two-door hardtops will get new uppers—roof and pillars similar to the two-door styling of GM's '73 intermediates. In 1975, four-doors will get the treatment. When this move is completed, all GM cars will be switched to the safer design. PS

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Can you spot the Camel Filters smoker?

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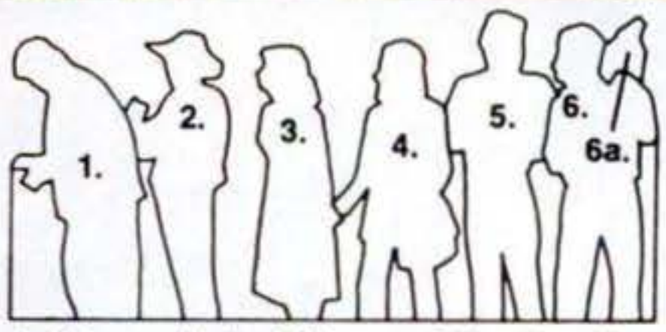

In this picture everybody has a gimmick... almost everybody. Try picking the one who doesn't go along.

1. Nope. He's Alfonso Cliggitt, divorce lawyer. Gimmick: far out dress to intimidate the opposition. Smokes cigarettes made of dried tundra. **2.** Harold A. Baer, rare book expert. ("Books Old and Rare from Harry Baer.") Thinks rolling his own makes him look younger. A real dingbat. **3.** If she's the Camel Filters smoker, the guy with the beard is Jean Harlow. **4.** Gene Harlow. **5.** Right! He's just himself. And he sees through all the gimmicks. That's why he smokes an honest, no-nonsense cigarette. Camel Filters. Easy and good tasting. Made from fine tobacco. **6.** A. Boswell Farquar. Gimmick: a white (not green) parrot. Hasn't seen a movie in years. They won't let his parrot in. **6a.** Parrot. Smokes a meerchaum pipe but has trouble keeping it lit.

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20 mg. "tar," 1.4 mg. nicotine av. per cigarette, FTC Report AUG.'72.

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What makes Mustang different is the way it looks, handles, and makes you feel.

Mustang options, many of which are shown on the Grandé model above, include automatic transmission, air conditioning, AM-FM stereo radio, power front disc brakes, white sidewall tires, steel-belted radial-ply tires, and more.

Better idea for safety . . . buckle up!

Body styles from top: Hardtop, Convertible, SportsRoof.

This luxurious Grandé interior is shown with optional arm rest/storage compartment.

There are at least three reasons why Ford Mustang has been the top-selling car in its class since 1965.

Good looks. Mustang is sporty and sleek. Inside and out. Your choice of five models: Mach I, SportsRoof, Grandé, Hardtop and Convertible.

Good handling. Mustang's low silhouette and compact size make its handling as beautiful as its looks. You get independent front suspension with anti-sway bar, for decisive sporty car handling with a comfortable passenger-car ride.

Great feeling. Driving a Mustang adds up to a statement of personal style. It feels great to you... it looks great to whoever's watching.

Discover Mustang for '73, at your Ford Dealer's.

FORD MUSTANG

FORD DIVISION

All 1973 cars must meet Federal Emissions Standards before sale. See your Ford Dealer for details.

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Popular Science
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PS: What's News...

Keeping You Posted from Behind the Scenes

Rumors that Polaroid's Dr. Edwin Land had another far-out invention up his sleeve kept us digging for the past couple of years to get hard information. Polaroid wasn't talking, and Dr. Land proved to be as sly about protecting his secrets as he is creative in developing his inventions. It seems that he concealed the true nature of his "impossible" new color system by getting his patents on bits and pieces of it attached to a variety of decoy cameras.

Last April, on a hunch, Science and Engineering Editor Arthur Fisher went to Polaroid's stockholders' meeting. There he saw the first public demonstration of the remarkable SX-70—but they wouldn't let him take pictures with the new camera or of it. Neither would they reveal technical details.

The trail of the SX-70 next led Fisher to San Francisco and the meeting last May of the Society of Photographic Scientists and Engineers. Dr. Land presented his new camera to his peers in somewhat greater detail, but again no picture-taking was allowed. This time Fisher was prepared. He brought his wife along—sketch pad in purse. Between them they brought back enough information for artist Ray Pioch to make the revealing drawing you saw in our July story on the camera.

Finally, Fisher got his hands on an SX-70 on a Friday after our deadlines for the January cover and color pages. Could the story wait for February? With the camera coming on the market now, we decided no. By shooting all color between Friday afternoon and Monday—and bending some production schedules—the SX-70 and Fisher wound up on our January cover. You can see some of the pictures he took with it and read how the incredible camera works in the story starting on page 84.

PRTs are rolling

One of the PRT systems we told you about in our November 1971 issue is now carrying passengers. If you happened to be at one of the stations on the West Virginia University campus in Morgantown, you could press a button selecting your destination, the system computer would dispatch a car to pick you up and guide your car, nonstop, to the destination you selected. You would ride in a rubber-tired vehicle along a double-tracked concrete guideway at 30 mph. In its present initial phase, five such vehicles are operating. Ultimately the system is designed to handle 60 cars.

New entry in low-emissions sweepstakes

Honda is demonstrating a piston engine reminiscent of the Ford stratified-charge engine [PS, July '68] which they say will meet the '75 emission standards and has proved its 50,000-mile durability. Honda calls theirs the Compound Vortex Controlled Combustion Engine (CVCCE). Both Ford and GM are reported to be talking to Honda about rights to make it in the U.S. Honda has been working on the CVCCE for more than three years. They have built over 100 test engines. Each cylinder has a precombustion chamber connected to the main chamber by an open channel. It uses a carburetor —not fuel injection. Fuel stratification inside the chamber allows combustion to start in a rich mixture and spread through progressively leaner mixtures, assuring complete combustion.

Update on really big TV pictures

In our September article about Advent's new projection TV system, we reported that their schedule promised that the system would be on the market in September. Now they tell us their production schedule has slipped a bit, but that you should be able to buy one by the time you read this. Don't expect to find it in your local store, though. A spokesman says enough people around New England have already expressed interest to take their two-a-day production for some time.

Wankel's Zisch boat revisited

While he was in Europe this past Fall, Auto Editor Jan Norbye visited Dr. Felix Wankel again. Naturally they had a lot to talk about on engine developments, but Jan also got a progress report on the Zisch boat he told you about in our June, '72 issue. There was some good news and some bad news. The Zisch boat, you'll remember, is Dr. Wankel's answer to highway traffic congestion—a high-speed personal vessel that skims across ocean waves at 60 mph.

A full-scale prototype has been built. It displaces about one ton. Overall length is 265 inches and the draft at standstill is 46 inches, reducing to about 18 inches at speed. During the first test on August 11, 1972 it failed to reach design speed. The prop turned out to be the wrong size and pitch to allow the engine (a Wankel, of course) to turn up the 6000 rpm needed to develop full power.

Laws to force use of seat belts?

There's more and more talk in state legislatures supporting laws requiring motorists to wear their seat belts. Persuasion hasn't worked. Maybe ad agencies can sell refrigerators to Eskimos, but they haven't been able to sell most of you on buckling up to save your life. A recent research study conducted before and after an intensive TV ad campaign to "buckle up for safety" showed practically no improvement in the percentage of motorists using their belts.

The life-saving effectiveness of safety harnesses is beyond question. Both tests and experience prove daily that seat belts—especially worn with shoulder harness—save lives and prevent crippling injuries. The stubborn refusal by the majority of motorists to suffer the minor inconvenience of buckling up to save their own lives has provided the thrust behind Federal regulations requiring air bags in new cars beginning in 1975.

But why continue the highway slaughter unabated between now and 1975? Australia has a mandatory seat-belt law and it's working, according to the reports we get.

Hubert P. Luckett
Editor-in-Chief

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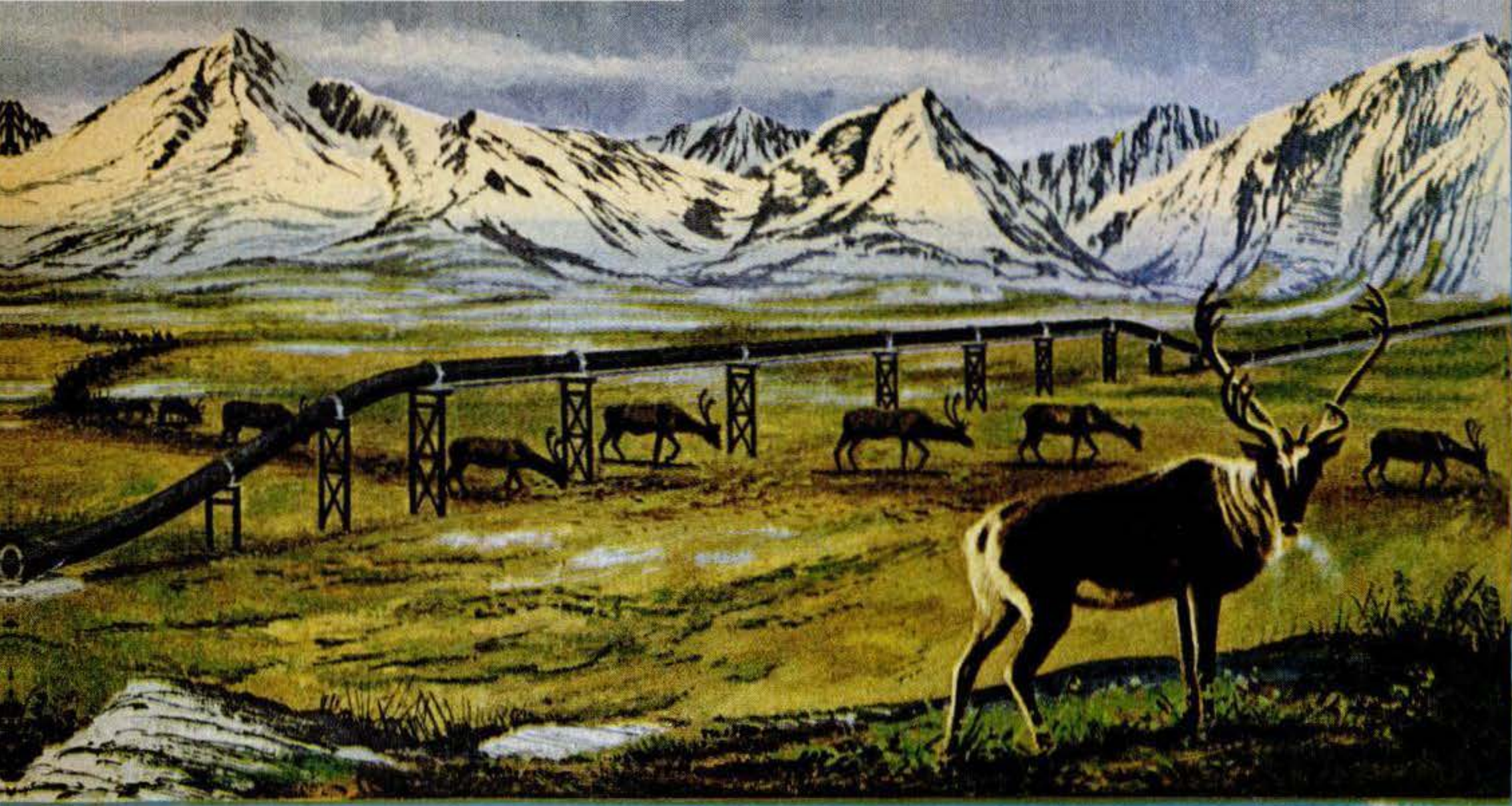


Wildlife underpasses are planned for 177-mile pipeline section supported by gravel/concrete pads. Tests show caribou ignore structures.

Alaska Pipeline Plan Spins Off a Science Bonanza

Will a 789-mile oil line harm the state's ecology? Studies seeking the answer have yielded massive data — and new safeguards

By JOSEPH E. BROWN
ILLUSTRATION BY DEAN ELLIS

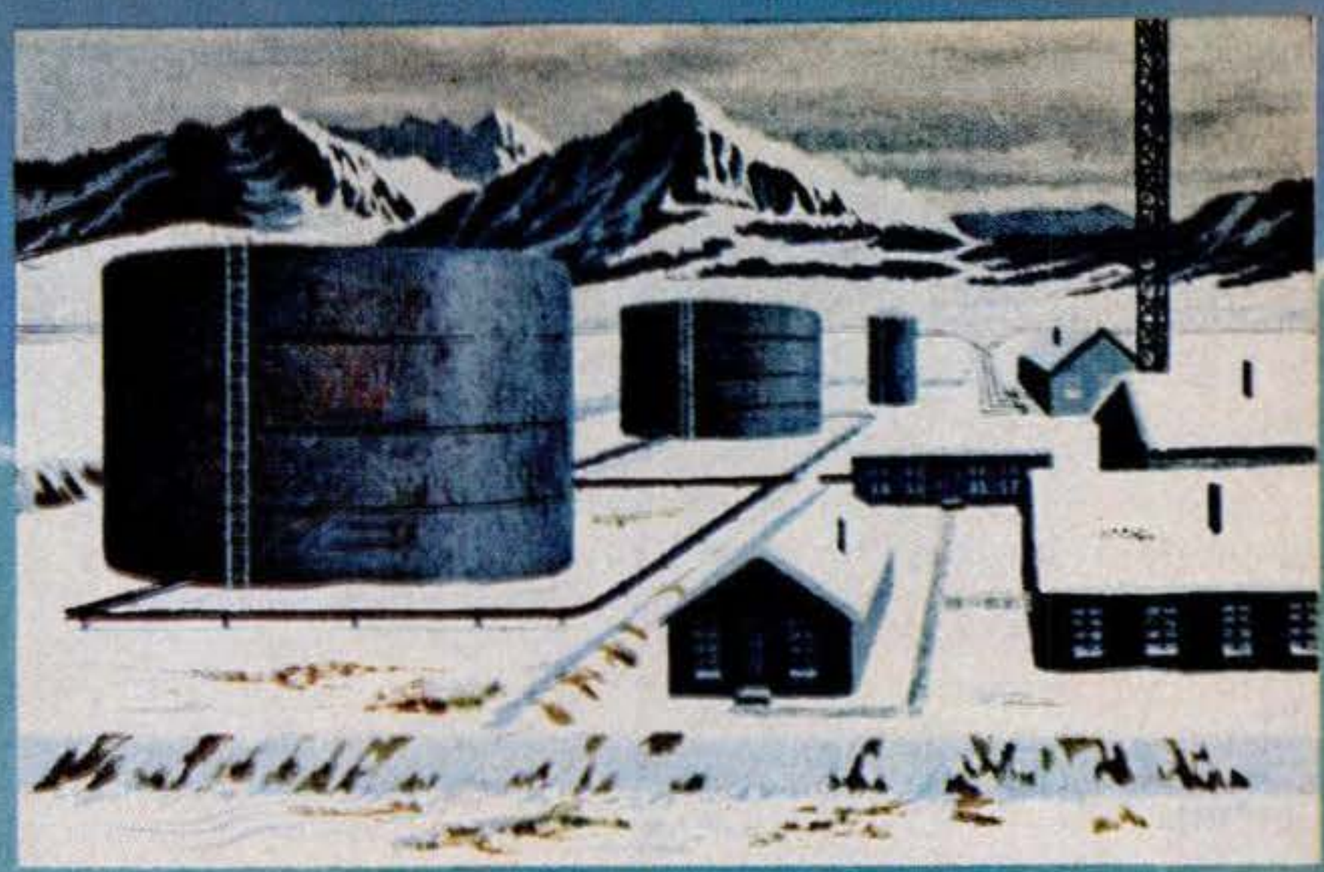
Conventional burial is possible for half the line where heated pipe won't thaw and weaken support.

Beneath the Otter twin's wingtips, Alaska's Oklahoma-size, treeless North Slope stretched out like a white blanket, reaching for the Arctic Ocean beyond the horizon. Under the North Slope's tundra lie three pools of oil that may exceed any previous discovery: 10 billion barrels. Oil companies paid $900 million for lease rights alone.

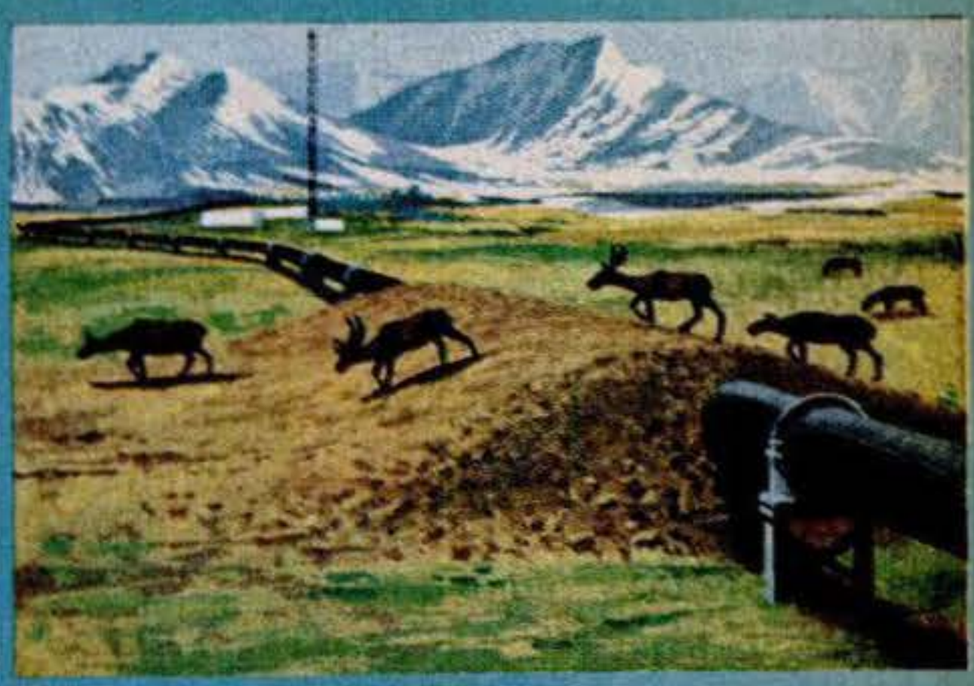
I was flying the route of the proposed $3 billion, 789-mile trans-Alaska pipeline from the ice-free port of Valdez, the line's southern terminus, to Prudhoe Bay north of the Arctic Circle. In the stillness of wilderness Alaska, it was easy to understand the concern of environmentalists that pipeline development might permanently disrupt the ecology.

After a week-long, 2000-mile trip along the route, one impression emerged above all others. Whatever the pros and cons of construction, Alaska has benefited greatly from the spinoff of more than 400 separate environmental impact studies generated by the oil discovery. Alaska is the first major test of a new doctrine: A project must be proved environmentally harmless, or at least its benefits and damage must be reasonably in balance, before a spadeful of dirt is turned.

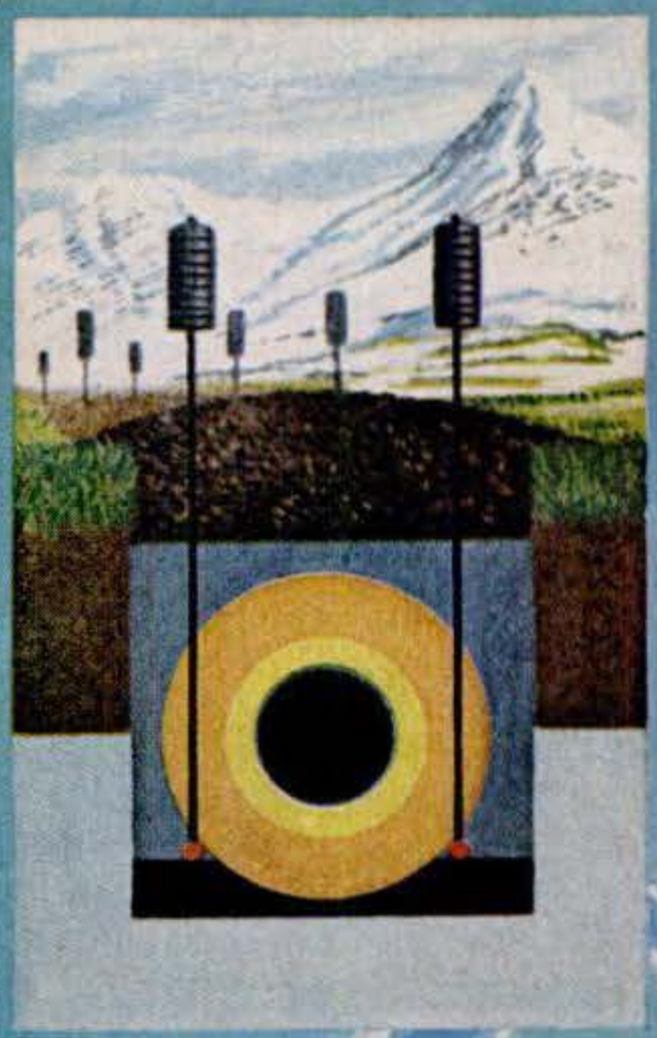
(Continued)



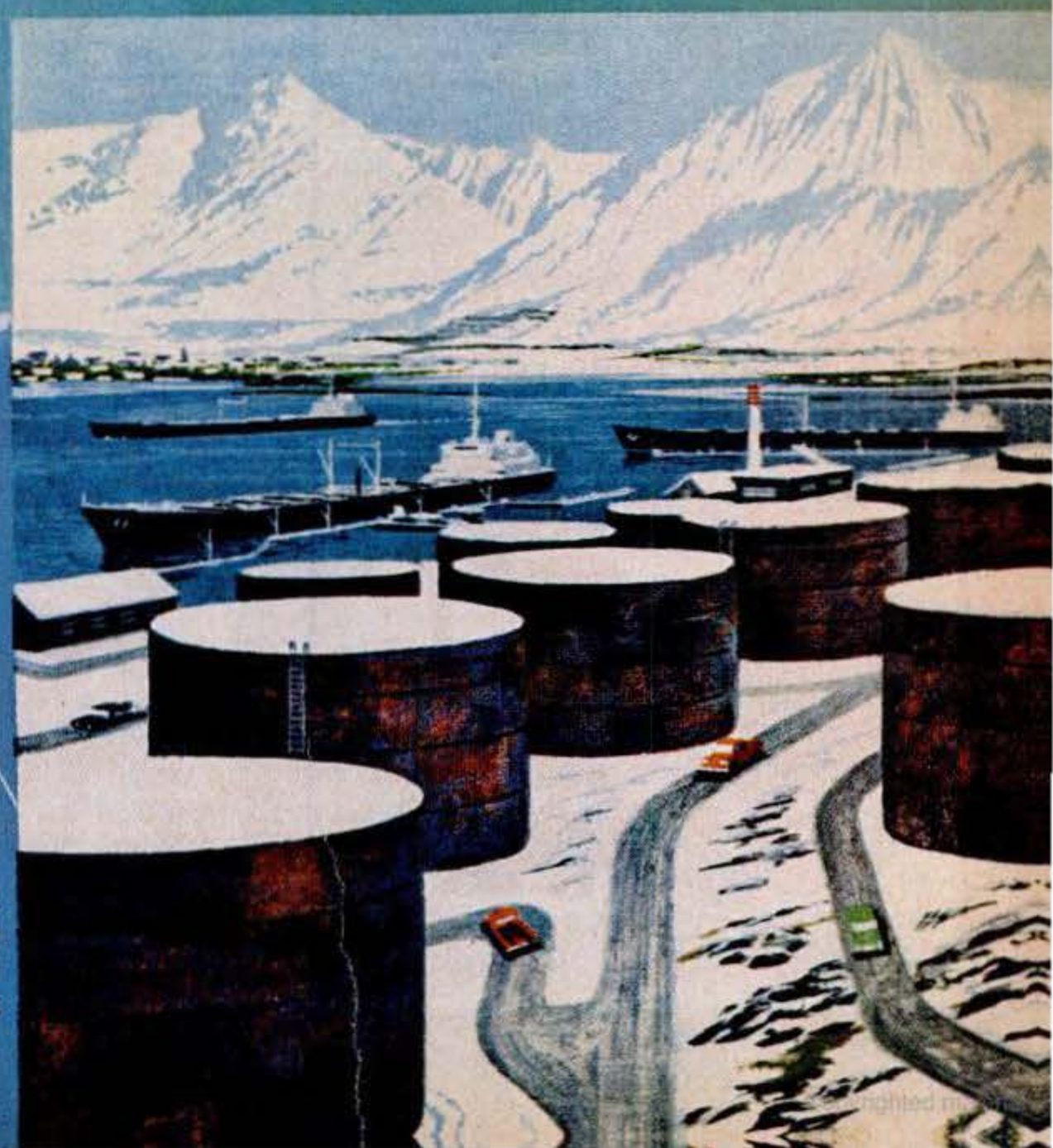
Origin station at Prudhoe Bay would collect oil from producers. First of 12 pumps along line (squares) initiates two-million-barrel-a-day flow.



Pile technique—with caribou ramps—may be used for 178 miles. Remote-control valves could block oil flow.



Insulated burial for 70 miles would prevent permafrost thaw. Heat-sink devices could transfer heat to air.



Tankers docked at Valdez terminal port would load oil piped 789 miles from North Slope for shipment to the West coast.

BARROW

PRUDHOE BAY

BETTLES

LIVENGOOD

FAIRBANKS

VALDEZ

The impact studies were initiated after a 1970 injunction won by environmentalists blocked the project. The federal court ruled that the Department of the Interior, which had given the go-ahead for construction, had failed to demonstrate the pipeline's potential impact on the state's ecology.

As a result of the studies, major changes affecting design and routing of the proposed line have occurred:

- Some 50 percent of the line would now be built above ground, instead of five percent as originally planned.
- Routing has been altered to protect wildlife.
- A device was developed to detect minute leaks along the line so shutoff valves could be triggered automatically.
- An earthquake-warning system was designed to detect quakes before they occur.
- In addition, a number of environmental "baselines" were established so scientists can determine if ecological changes occur.

Earthquake zone. Building a pipeline in the Arctic multiplies problems, both technological and environmental, faced elsewhere. Between Prudhoe and Valdez, the route will cross streams that are spawning grounds for grayling and trout.

Alaska, too, is seismically active; in the past 70 years, 23 major earthquakes have rattled the terrain over which the pipeline will pass. And Arctic ecology is delicate, especially in the vast areas of tundra, where the 1800-foot-deep permafrost never thaws.

"The job would be rigorous even in warm climate," acknowledges E. L. Patton, president of the Alyeska Pipeline Service Co., a consortium of seven oil companies formed to design, build, and operate the project. "In the hostile mountains and tundra, it's formidable. The line must cross three mountain ranges, including the 150-mile-wide Brooks Range, and 350 rivers and streams. It must account for glaciers," says Patton.

Following the discovery of oil in July of 1968, oilmen weighed and discarded other means of transport as either too risky, too costly, or too inefficient. They picked the pipeline as the most feasible, and engineers bent over their drawing boards. Normally, such a line would be routed along the shortest distance between terminal points.

Permafrost thaw. "But we couldn't do that in Alaska," an Alyeska engineer explained. "In operation, oil will heat up as it flows—as high as 145 degrees. In permafrost areas, that would melt the ice around the pipe, causing supports to sag and break. So we sought a route where we could run it instead through gravel and rock wherever possible; we'll pack the pipe in a heat-containing cement 'blanket' where it isn't."

If construction goes ahead, about half of the line—400 miles—will now be suspended above ground to prevent permafrost thaw. At intervals it would be raised high enough to allow caribou and other wildlife to walk underneath for grazing and migration.

The pipe itself, now stored at Valdez and elsewhere, had to meet rigid specifications and then was finally tested to 125 percent of its maximum operating pressure.

Alyeska engineers have also designed a novel device to test the *inside* of the pipe. Nicknamed "The Pig," it is a cylindrical, torpedo-like gadget fitted with electronic instruments. Before a drop of oil flows through the line, The Pig will wiggle its way 800 miles from the Arctic Ocean to Valdez in the south.

"Pigs" are standard equipment in pipeline operation, but their normal use is periodically to clean accumulations of scum from the pipe's interior. Alyeska's "pig," however, is considerably more sophisticated. Its sensors, for instance, will detect any weak joints or pipe sections and feed this data to a computer. Nonconforming pipe sections will then be replaced.

Studying the tundra. By far the most complex, expensive part of the study is the United States' $1-million Tundra Biome project. Sponsored by the National Science Foundation, it is part of the broader, five-year, 11-nation International Biological Program, a wide-ranging scientific exploration in both polar regions.

Tundra and its underlying, permanently frozen mat called permafrost have been little understood and little explored for many years, despite the fact that it covers 3,000,000 square miles of the Earth, or about 1/20 of its total surface.

"North Slope tundra," a veteran Alaska oilman told me, "is like a blank piece of paper. What's written on it stays written. Destroyed, tundra takes up to 40 years to regenerate." To illustrate, he described how a small ditch was cut not many years ago to drain a lake. "Today that ditch is 150 feet wide—and still widening," he said.

Environmentalists feared that pipeline activity would disrupt tundra ecology beyond redemption.

Tundra tests. To determine if it would, Biome scientists set up experimental stations near Point Barrow. Some sections of tundra they plucked bare (as grazing caribou might). They doused other sections with toxic substances. They buried heat sensors in some and spread fertilizers on still others. To determine how the pipeline will affect tundra vegetation, Alyeska then punched 3000 test holes to sample the soil underneath. The conclusion: Half of the pipeline could safely be buried, the rest elevated.

[Continued on page 130]

U. S. Senator Mike Gravel comments on the trans-Alaska pipeline

It would be easy to brush off as biased anything an Alaskan had to say in favor of the trans-Alaskan pipeline proposal. There is no question that the development of the North Slope oil fields is important to the State, primarily in terms of economic development.

In 1970 the oil industry contributed some $50 million in payrolls to the Alaskan economy, and provided approximately 5000 jobs. Beginning the pipeline next year should increase that substantially. The Interior Department estimates that by 1976, at the height of the pipeline construction period, the oil industry will generate some $400 million in personal income and create something like 30,000 jobs.

We need the jobs for Alaskans and we need the new Alaskans that the jobs will bring north. Alaska needs the jobs for a prosperous and stable economy in the state.

As an Alaskan, these things might temper my judgment on the wisdom of a line carrying two million barrels of oil every day from Prudhoe Bay in the Arctic to Valdez on the Gulf of Alaska. But overriding my economic self-interest is my concern for the Alaska environment, a concern shared by all Alaskans.

No one who has witnessed the migrations of caribou herds across the Arctic tundra, flocks of ducks and geese returning north to their nesting grounds each spring, or salmon making their yearly trip upriver, could be insensitive to the beauty and delicate balance of nature in the "Great Land." I have always believed that we possess the technological expertise and skill to build a safe pipeline.

After carefully weighing the evidence of the Department of the Interior's six-volume study on the pipeline, I am certain of it.

The study itself is the most extensive ever undertaken to

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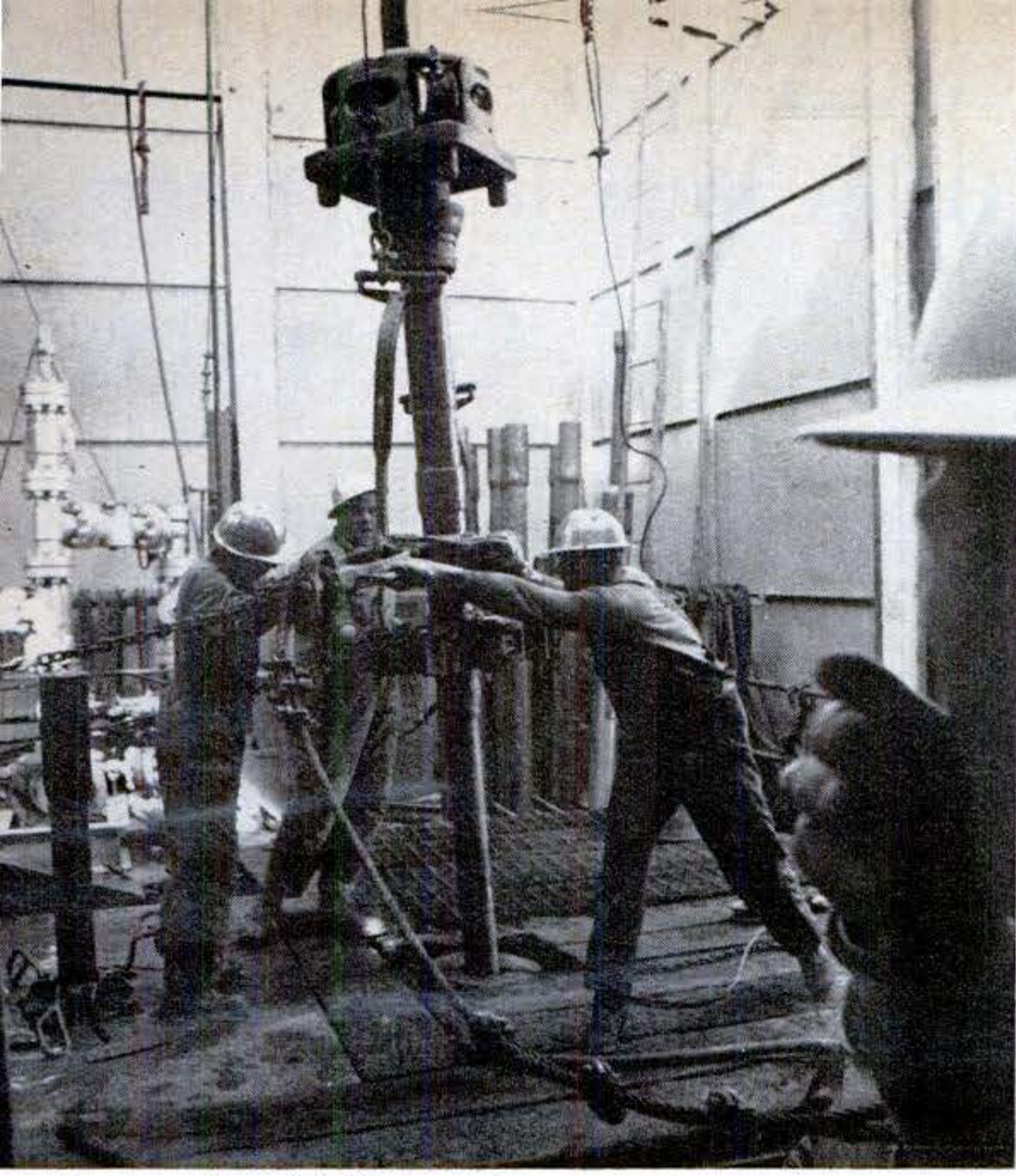
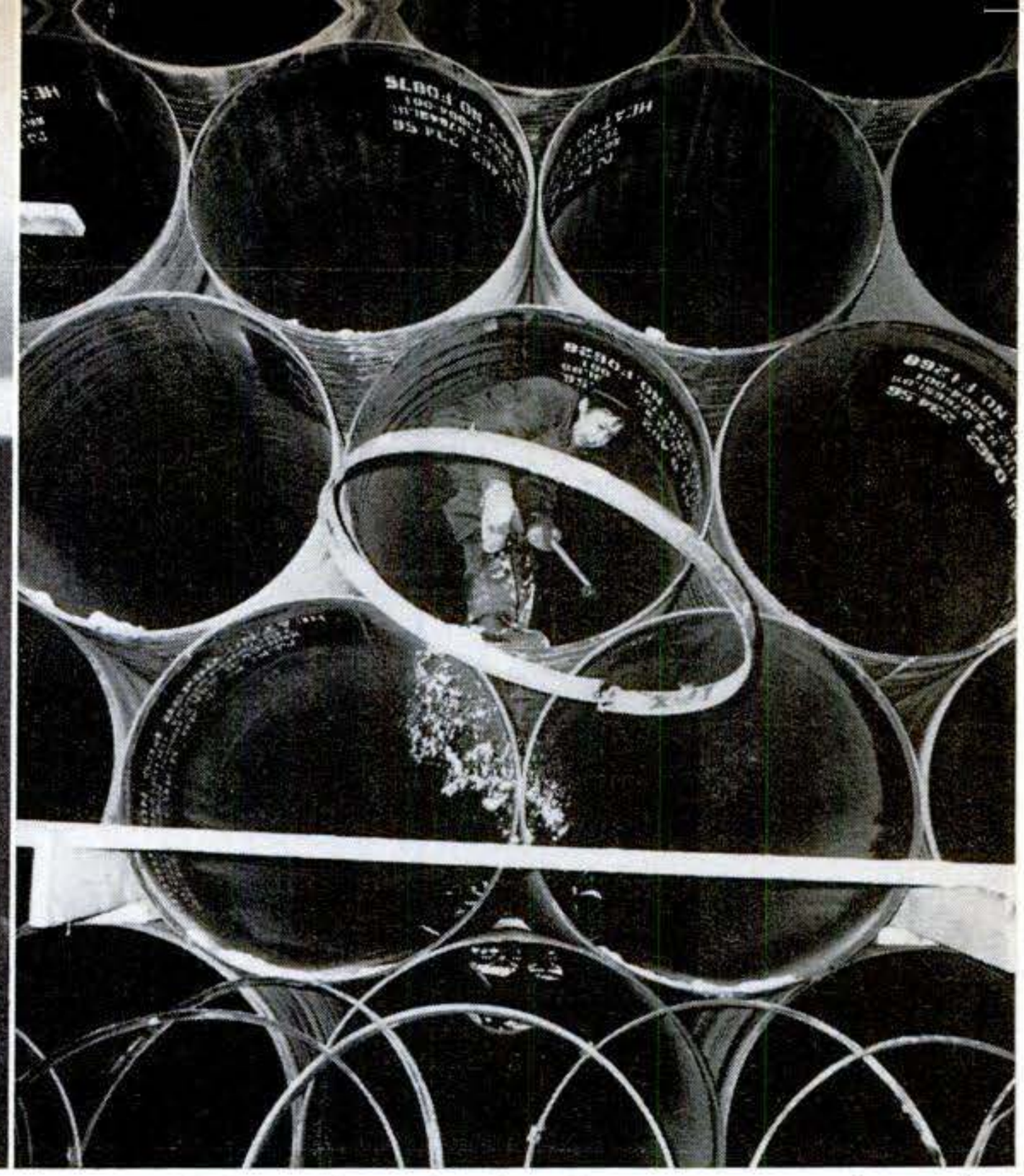
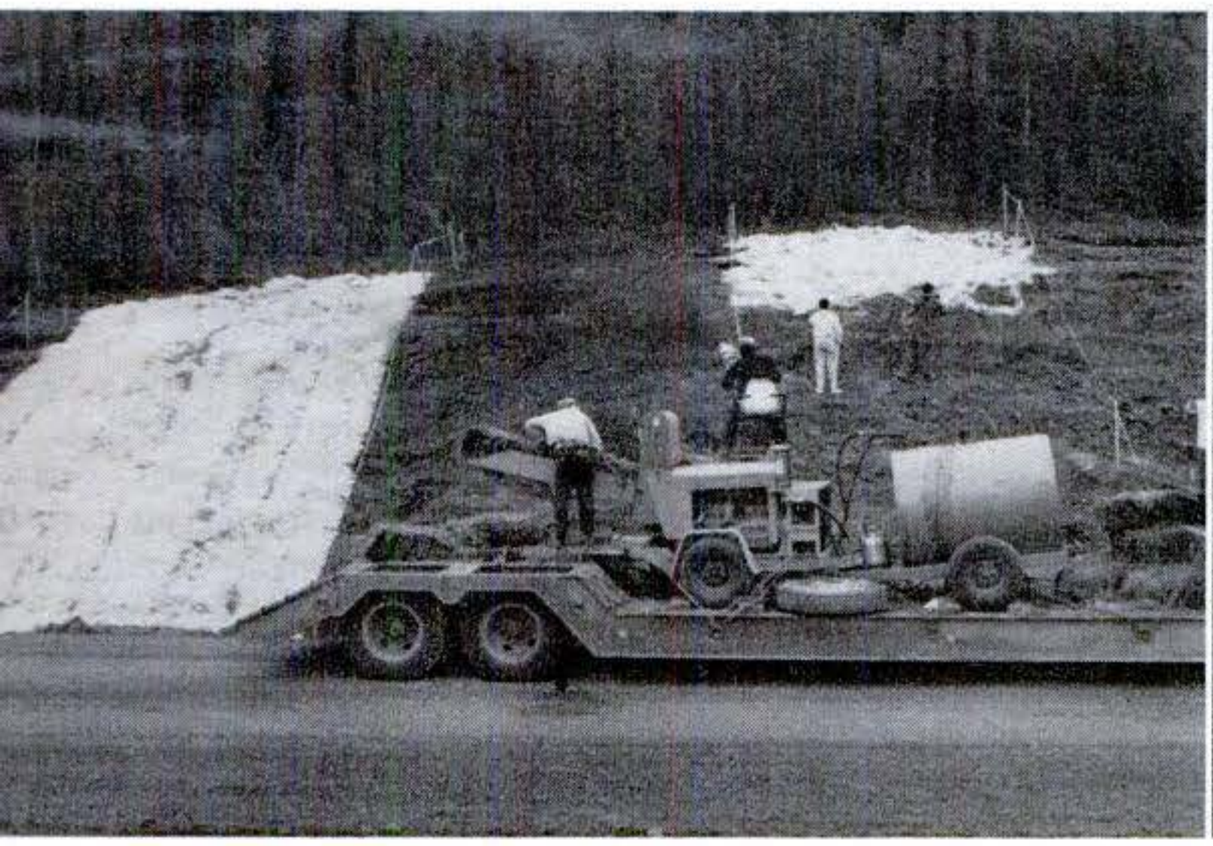


Oilmen work a drill bit into place at Prudhoe Bay. Because of extreme cold in winter, a building is erected for protection.



Native Alaska workman knocks off a protective steel ring from 48-inch oil pipe. All the pipe is now stockpiled in Alaska.



Vegetation tests were conducted along haul road north of Fairbanks to check effects of construction on trees and plants.

Helicopter lowers equipment and supplies to a crew conducting seismic studies for the pipeline on Alaska's barren North Slope.

determine the effect of man on nature. Its conclusions are that little, if any, lasting damage will be done to the environment. Moreover, it makes mandatory certain standards that contractors must follow. These standards guarantee environmental protection.

Provision is made for pollution control in all forms. The pipeline contractor will have to provide buffer strips one-half mile wide from wildlife areas, parks, historic sites, national landmarks, recreation areas. Fish and wildlife protection is contractually covered, and the restoration of any disturbed areas is required.

The pipeline itself will be designed to withstand anything but the most severe earthquake. And damage from such a catastrophe will be minimal, since the design requires remotely controlled shut-off valves at all pump stations. In areas of terrestrial instability, a network of ground-motion detectors will be installed and coordinated with a fast moving shut-down system.

But there are a number of other considerations as well. Our diminishing domestic supply of petroleum, and the uncertain future of our traditional foreign supplies, make it foolish to ignore the reserves estimated at between 10 and 16 billion barrels of oil on the North Slope.

Finally, since time is of the essence, speculation as to the practicality of a trans-Canada line is less than reasonable. Not only has opposition been voiced by Canadian conservationists, but there are indications that it is not practical at this time. Atlantic-Richfield recently said that after researching the feasibility of such a project they did not consider it a "viable alternative" to the trans-Alaska route, and announced their withdrawal from a group studying its potential.

The proposed trans-Alaska pipeline will be the cheapest, fastest, and, most importantly, an ecologically safe way to exploit Alaska's vast petroleum reserves.—*Mike Gravel*

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Strapped in the side-by-side, two-seater McCulloch J-2, author Kocivar gets ready for takeoff and another flying lesson.

Half-copter, half-airplane:

Can the

Air and Space 18A begins landing flare-out for touchdown in grass field on main gear. Approach speed is 40 mph with two aboard; 30 mph with one. Landing can be made at zero mph.

By BEN KOCIVAR / *PS Consulting Editor, Flying*
ILLUSTRATION BY RAY PIOCH

My left hand inched the autogyro's throttle to full power. At the top of the short handle my thumb rested on a tiny button, much like a mike switch. I checked gauges. Manifold pressure, 30 inches; rotor rpm, nudging 370; prop rpm, a bit under 2000.

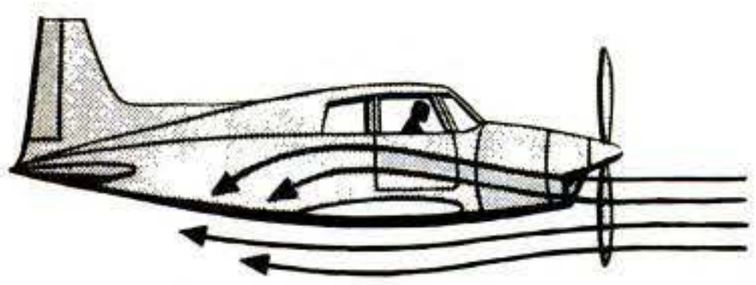
I pressed down with my thumb and, as though the craft were at the end of a giant stretched rubber band that snapped, we were almost 20 feet in the air. The pusher prop behind me surged to 2700 rpm and the air speed started moving quickly from what seemed an instant 20 mph to 50. I started my climbout from a farmer's backyard in Phoenixville, Pa.

Handling the controls at first is a bit like flying a helicopter. I had just gotten over the tendency to shilly-shally around the sky—overcontrolling while trying to hold a heading—when, wow, a fine sensation of floating, as if I were suspended from a pulley.

Finally, I made my approach to land, slowed down to nearly zero forward airspeed at about five feet off the ground, then gently touched down.

That's what my first solo in the Air and Space 18A autogyro was like after four hours of instruction.

What's new about the autogyro? It's been around for years. But now two companies are exploring the possibility of putting improved versions to work on a commercial basis. It

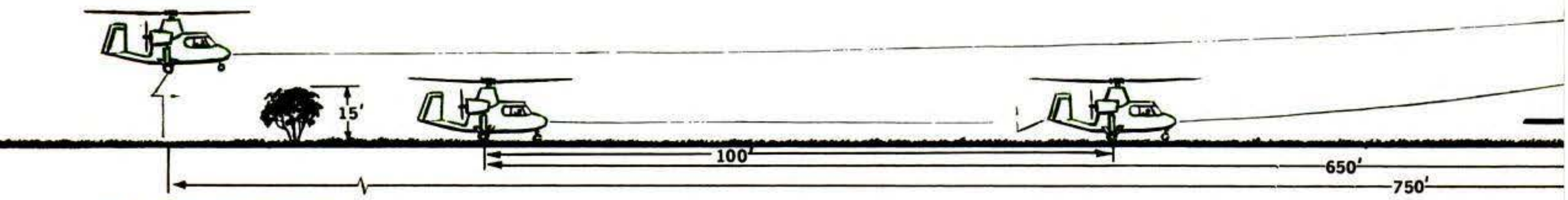


CONVENTIONAL AIRCRAFT get wing lift from curved airflow causing low-pressure area on top. High pressure below moves toward low, pushes wing up.

HELICOPTER goes up because overhead rotor pulls air down. During forward flight, chopper is in nose-down attitude. Tail rotor counters rotor torque.

AUTOGYRO rotor is not powered in forward flight, and lift comes from air flowing through blades from below. Flight angle is like that of a fixed-wing plane.

AUTOGYRO TAKEOFF is quick like a rabbit. The Air and Space 18A can make a 15- to 20-foot vertical hop from rough ground, mud, or snow, then fly level until climbout speed of 50 mph is reached. A 750-foot area is required to clear a 50-foot obstacle on a hop takeoff. If the ground is smooth, the autogyro can do a running takeoff like a conventional plane. Craft is airborne after 100 feet; distance to clear 50-foot obstacle then is about 650 feet, but decreases with higher headwinds.



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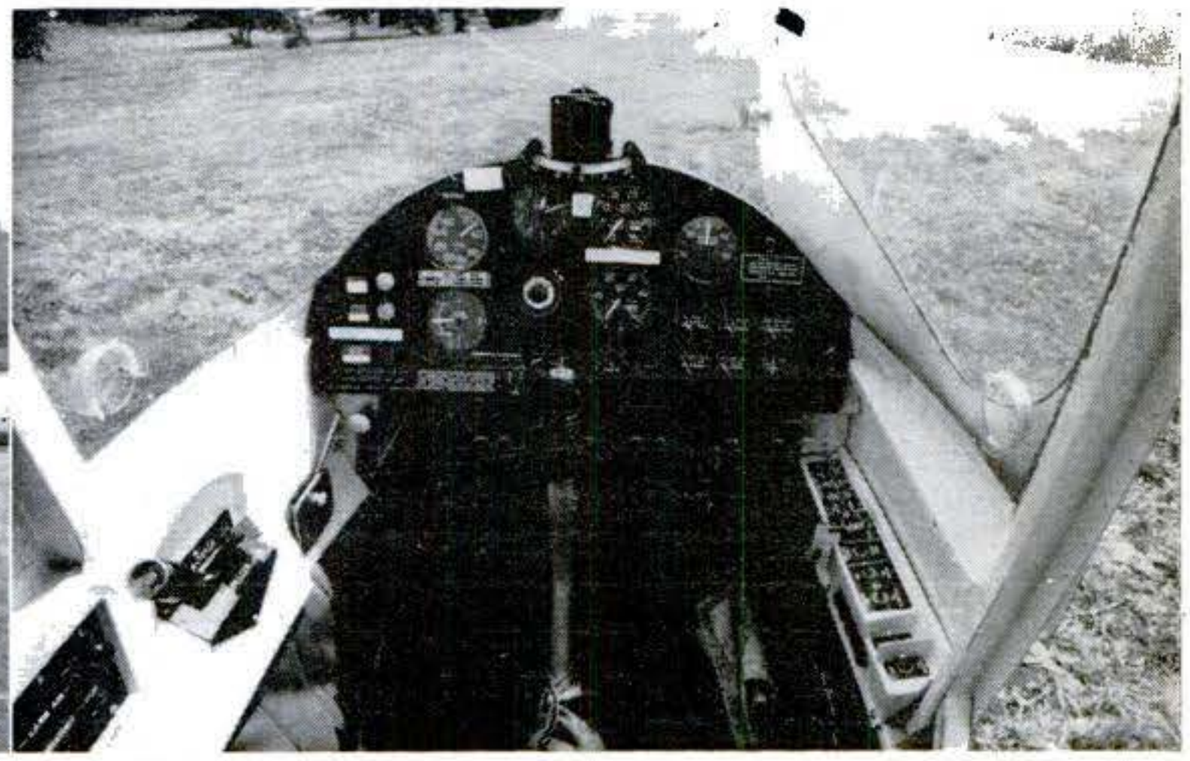
A few sparks of interest may make a 50-year-old rotorcraft a factor in the short-haul transportation picture

Autogyro Make a Comeback?

Autogyros can use most designated heliports because of their ability to do no-roll landings and hop takeoffs. The Air and Space 18A easily got in and out of New York's Wall Street heliport.



Instruments in 18A are same as in most small airplanes. Additions include rotor-rpm gauge and pitch and clutch buttons that set rotor-blade angles and engage rotor to engine on takeoffs.

might work out. There's growing demand for efficient point-to-point travel. Crowded airports, traffic restrictions in the sky, and the growing, spreading population make the old autogyro look like a new answer.

What's wrong with a helicopter, you ask? Copters are dandy but take lots of bread. At $20,000 to $25,000 to buy and $30 per hour to operate, autogyros cost half to one-fifth as much on both counts. And although they can't quite do the same thing as a helicopter, they come very close. Like the helicopter, they can operate from places an airplane can't (such as heliports), but can't fly as fast or as far without refueling.

How they differ. To refresh your memory: an autogyro only *looks* like a helicopter. Its rotor is freewheeling —it's not driven by the motor as the helicopter's is.

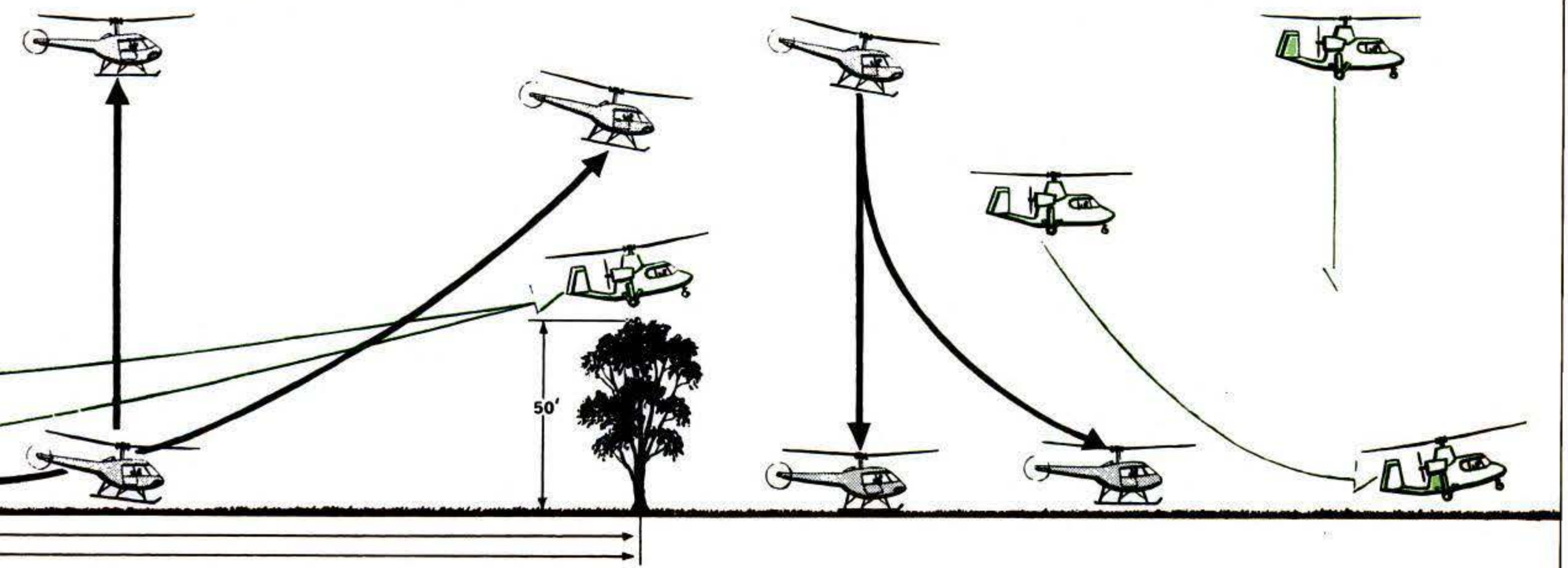
Thousands of plans and parts have been sold for the popular home-built Bensen gyrocopter. (An autogyro is also called a "gyrocopter" or "gyroplane.") They're fun and exciting, but fly only as experimental aircraft ["How You Can Own and Fly Your Own Whirlybird," PS, July '70]. The ones I flew are certified production-type craft with a 200-mile-plus range.

Both the Air and Space 18A and the McCulloch J-2—which I also flew—are

Continued

HELICOPTER TAKEOFF can be straight up, depending on payload and air density. Normal takeoff for safety involves low-level forward flight to over 15 mph and then climbout to about 500 feet per minute. A small helicopter clears a 50-foot obstacle in about 350 feet on normal takeoffs. Stronger headwind makes climbout angle steeper, cuts obstacle clearance distance.

HELICOPTER AND AUTOGYRO LANDING: With powered rotor a helicopter can land vertically, but normally makes safer approach with forward speed so if engine fails it can autorotate. Autogyro can descend vertically between 1000 and 2000 fpm, but must have forward speed to slow descent for safe landing. Rollout or zero forward-speed landings are possible.



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Triple-tailed 18A is slightly bigger, heavier, slower, with more range than the twin-tailed McCulloch J-2. Both have pusher props, three-bladed rotors, two seats. Both may be outfitted with new rotors, three-bladed props, a bigger power package.

two-seaters; the 18A is side-by-side, the J-2 tandem. Although both machines are far from a commercial version, improvements are being planned for better performance and more utility. There are long-range plans for bigger and faster machines.

To get the feel of what autogyros can do, and what improvements are in the wind, I soloed one, and flew the other with Pan Am pilot Don Farrington. We took off and landed from the big Wall Street heliport in New York and landed at a small helipad with a diameter no greater than the 35-foot diameter of the 18A's rotor.

Time after time at various airports, we asked for and got permission to hop off from a clear taxiway or a grass space off the active runway. Meanwhile, half a dozen impatient planes were lined up waiting their turn to take off. We had the same advantages when landing. And this, of course, was in addition to our ability to land and take off from open spots away from airports.

On one of the cross-country flights I made with Farrington, I learned first-hand the advantages of an aircraft of this type over a conventional plane. We took off in weather with the ceiling under 500 feet on a trip slightly over 100 miles. We ran into light rain and lowering clouds but were still able to stay a few hundred feet over the countryside. Finally, in the foothills of Pennsylvania the scud was getting dangerously low and it was almost dark.

We looked over a couple of ploughed fields, selected one that looked clear, and sat down safely. Just as we shut down the engine, a couple of farmer's cars and trucks pulled up to see if we needed help. The nearest hotel was 20 miles off and the weather showed no signs of improving. The local postmaster offered us the hospitality of room and board. We delightedly accepted and found he and his son were PS readers, which added a fillip to the evening there.

Next morning the weather was clear. With hearty good wishes we cranked up and did our hop takeoff into the blue.

Besides their ability to get out of bad-weather jams, these machines are fantastic for all kinds of special uses. In the New York area they are proving to be cheaper and faster than taxis between airports.

They get passengers out of the traffic mess on the ground on the runway as well as the highway. A New Jersey building contractor who was extending a pier runway at LaGuardia Airport into the East River used a J-2 to slip past the dense airline traffic to bring engineers to the site.

Plenty of applications. Proponents of the autogyro are considering other uses where the lower cost compared to a helicopter will prove to be a big advantage. There is increasing interest in flying-ambulance choppers that can leapfrog traffic jams and get medical attention to accident victims fast. (In Vietnam, battlefront casualties get to hospitals faster than auto accident victims in the U.S.) Gyroplane fans believe they can do this job for much less money. That means more flying ambulances could be available.

Big cities already have TV and radio stations and police departments with helicopters for traffic reporting. London's police department is considering buying three Air and Space 18A's. A TV station in the midwest is thinking about replacing a helicopter with an 18A for use by a flying girl reporter. If they do, she won't have too much trouble learning how to fly one of these things.

Flying an autogyro is different from flying a fixed-wing plane or a helicopter, although it combines features of both.

I first flew the 18A when it was called the Umbaugh 18, about 12 years ago. It had a V-tail then, but now it has a triple set of fins, the center one of which has a rudder. Since autogyros are powered by the pusher prop (see diagram), they need no tail rotors. Helicopters, powered by the overhead rotor, use tail rotors to counter the torque of the spinning overhead rotor.

Rabbit hop. Takeoffs for an autogyro usually require a ground run of about 300 feet. But the Air and Space 18A has a unique "hop" or "jump" capability. Through a belt and clutch linkage, it's possible to apply the pusher-engine power temporarily to the overhead rotor before takeoff.

At full power, and the blades in flat pitch, the rotor spins at about 370 rpm. Push a button to increase pitch, and the rotor disengages from the engine. The craft leaps into the air about 15 or 20 feet and the prop takes over. At 50-mph airspeed you start climbing. You can clear a 50-foot obstacle in 750 feet from jump-off.

The obvious advantage of this hop-ability is for rough-terrain takeoffs—a rocky area, a ploughed field, snow or mud—where a rolling takeoff is impossible. The McCulloch, too, can get its rotors spinning before it starts rolling. This is enough to shorten its run to about 100 feet, but not enough to do a hop takeoff.

Neither autogyro I flew can engage overhead rotor and engine in flight. Strangely enough, the 18A can clear a 50-foot obstacle in a shorter forward distance in a running takeoff than in a hop takeoff. Both gyroplanes can land safely just about anywhere a helicopter can. But both need about 100 yards of clear area to get out.

At present, both aircraft are too noisy to be acceptable for off-airport community use, and both are too noisy in the cockpit. These are obvious problems and improvements are planned.

Both use the same Lycoming engine but could use more power. In the opinion of some experts, it should be

[Continued on page 122]

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Unable to attend school because of a brain-tumor operation, youngster sees and talks to teacher in classroom via cable system.

How 2-Way Cable TV Will Change Your Life

Soon you'll "go" to the doctor, store, or school at the touch of a button

By ROBERT GANNON

In the living room of a Reston, Va. home a few weeks ago I sat before an ordinary TV set, a push-button telephone in my hand, and participated in a remarkable demonstration. Under the guidance of a representative of MITRE Corporation, I used the TV set as an information-gathering device.

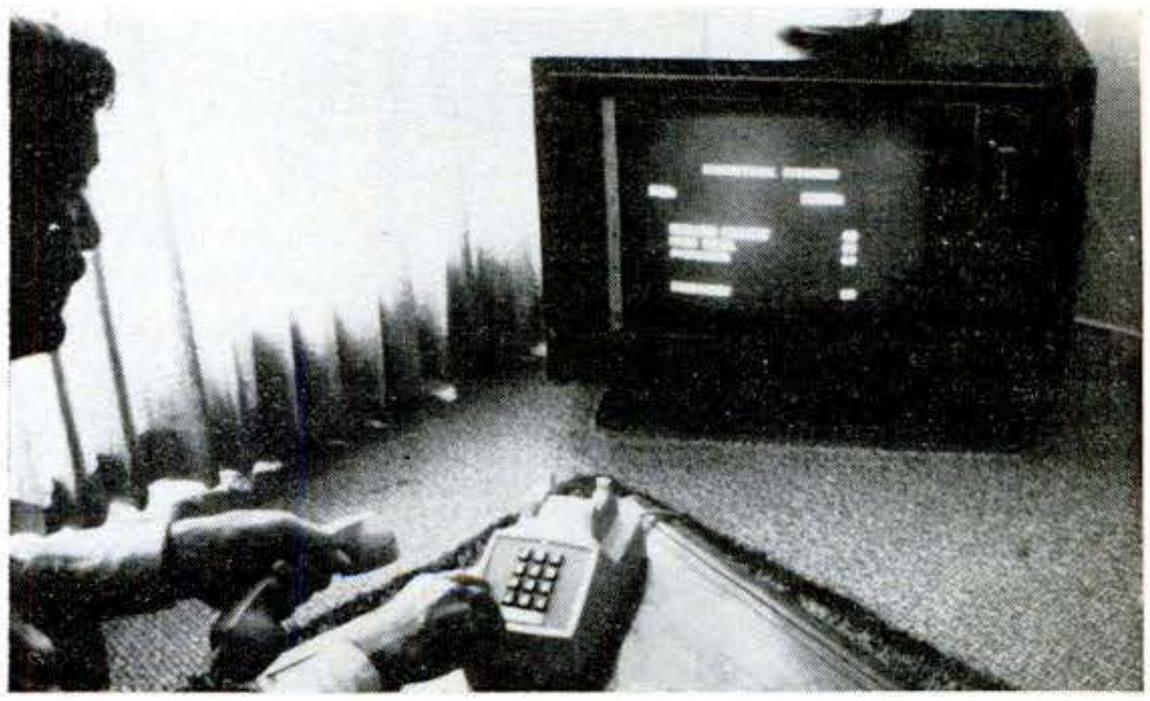
Simply by punching out the right number combinations, I (1) found out what was happening in Reston that night, (2) balanced an imaginary bank account, (3) made an appointment with a fictitious lawyer, (4) checked a series of classified ads, (5) took a history test, (6) found the antidote for accidentally swallowed kerosene, (7) looked up a business in the Washington, D.C., phone book, and (8) held a two-way conversation with an electronic technician a dozen miles away.

The Reston setup is for demonstration purposes only. But it gives a good tip-of-the-iceberg look at what's coming into my living room and yours—perhaps in the next few years, undoubtedly within the decade.

A communications revolution. It's a whole new communications system known as two-way cable TV or "the wired-city concept." Two-way cable TV systems are already in use in Overland Park, Kans., and Orlando, Fla. It's just a matter of time before it gets to your town. And it will probably change your life.

TelePrompTer's Hubert J. Schlafly says two-way TV will be "the most significant development in social communications since Samuel Morse first transmitted codes over wires." Robert W. Galvin, board chairman of Motorola, claims the wired city will do away with the need for standard broadcast, and that we should set a date to close down all ordinary TV stations. Ed Harmon, project engineer for the Polycom two-way TV system, puts it this way: "Graham Bell invented a toy for the idle rich. Soon it became absolutely essential. Well, we're in the same place as the phone system three years after Bell invented it."

Author Gannon tries out Orange CableVision's two-way installation at headend in Orlando, Fla. He punches out request for information on home callbox and then waits for computer's answer.



Standard television set and pushbutton telephone are part of Theta Com's home installation in El Segundo, Calif. Subscriber queries headend; information flashes on TV set.

Continued

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What will two-way TV do for you? The most objective predictions say it will:

• *Enable you to shop from your home.* In Akron, Ohio, TeleVision Communications Corp., the nation's second-largest cable company, has already hooked the city's Cable-Vision System subscribers into a new two-way system. The company now is lending a large number of adding-machine-like consoles for an experimental home-shopping service. The local Sears store will display its merchandise on sale, and the housewife will order directly through her TV set.

• *Provide you with fire and burglar alarm systems.* By July, if plans go as expected, 4,000 homes in Irving, Texas, will have such systems installed. Executive VP Jim Scott of Topcom, Inc.—the company setting things up—also foresees such services as switching lights and sprinklers on and off automatically, plus possibly "some kind of medical monitoring—either electronic or video."

• *Enable you to vote easily.* By late this spring, 1000 cable subscribers in El Segundo, Calif., will be linked together in a test run by three cable giants: TelePromp-Ter, Theta-Com, and Hughes Aircraft. Viewers will vote on political questions and participate in quiz shows. In New York City, meantime, Sterling Manhattan has installed similar systems in 12 areas. So far, opinions on political issues, ads, and beauty queens have been queried.

• *Bring you local news quickly.* In Los Angeles' Watts section, the Mafundi Institute has set up a 400-unit, two-way system that allows subscribers to send signals back to the studios for distribution to all. Fifteen shoulder-pack videotape units have been placed around the area so that when something important happens, the event can be covered and piped into the network quickly.

When two-way TV becomes established, say those who watch trends closely, it will change the way you find out what's going on, shop, talk to your neighbors, keep track of your bank account and stocks, maybe even work. As Peter Goldmark, former president of CBS Labs, pointed out in the May, 1972 POPULAR SCIENCE, such an advanced system of communications networks "will do nothing less than give people a choice of where to live—and thus utterly transform our society."

Today people must live in cities because that's where the jobs are. But with super two-way communication (including high-speed facsimile devices), small satellite offices could be set up anywhere, and be just as close to the executive offices as those on a different office-building floor.

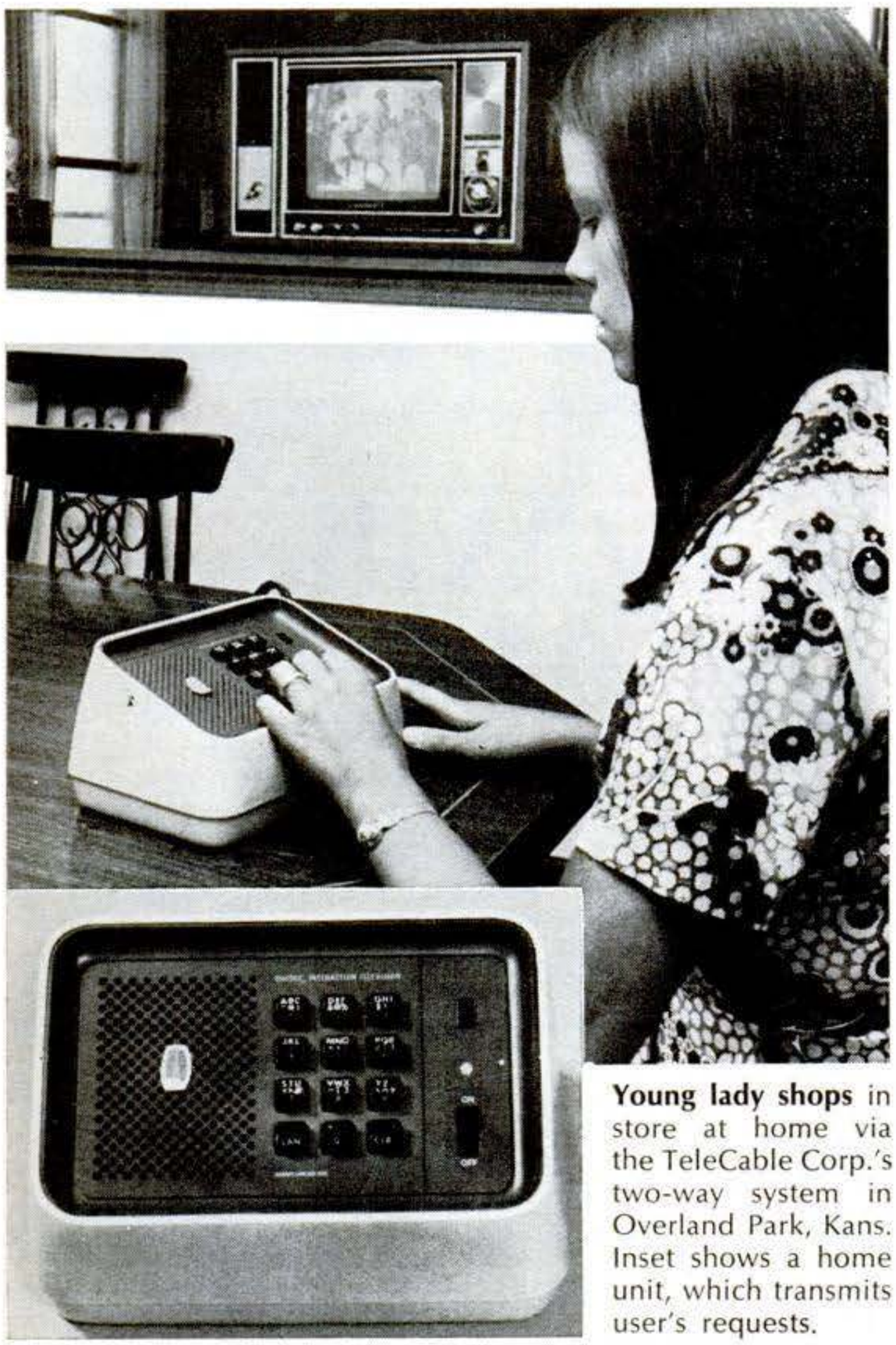
Hooking up the U.S. The nation is already being wired together at a remarkable rate. Half the households in the U.S., say most of those who should know, will be interconnected with a wire-and-microwave grid within eight years. And with nearly 1000 times the capacity of a telephone wire, cable's ability to carry information is staggering.

Right now nearly 3000 cable systems net together some 15 million people. Another 2500 or so cable franchises are pending, and this figure, like the number of cable-TV viewers, is increasing by 18 percent each year. Some cable systems, in fact, have more viewers than smaller conventional TV broadcasting stations.

Most cable TV lines now installed are one-way only—headend (the control station) to viewer. But that's gradually being changed. New FCC regulations require "two-way capability" in primary new installations, and as soon as two-way becomes established, public clamor is likely to force the old systems to change over.

The basic technology bringing this about is here already, and it's rather remarkable. As a good example, let's take a close look at that Reston demonstration—a likely candidate for your future. The system is called TICCIT, and the only equipment needed is a standard TV set, an ordinary pushbutton telephone, a video recorder (in the experiment, an ordinary Sony AV-3400 portable), and a "brown box," a *coupler/decoder* that essentially acts as a switch and identifier, so that you get whatever message you're supposed to.

Most channels a Reston viewer gets are standard from Washington and Baltimore. But flip to channel seven and you see a meaningless blur of pictures flashing at the rate of 60 per second, repeated every three seconds. (If additional frames were wanted, they could be repeated less often—say, every 10 seconds, which would allow 600 different pictures to be sent.)



Young lady shops in store at home via the TeleCable Corp.'s two-way system in Overland Park, Kans. Inset shows a home unit, which transmits user's requests.

Subscriber units like Theta-Com's are part of home setup that includes coupler-decoder "brown box" and viodeotape recorder.

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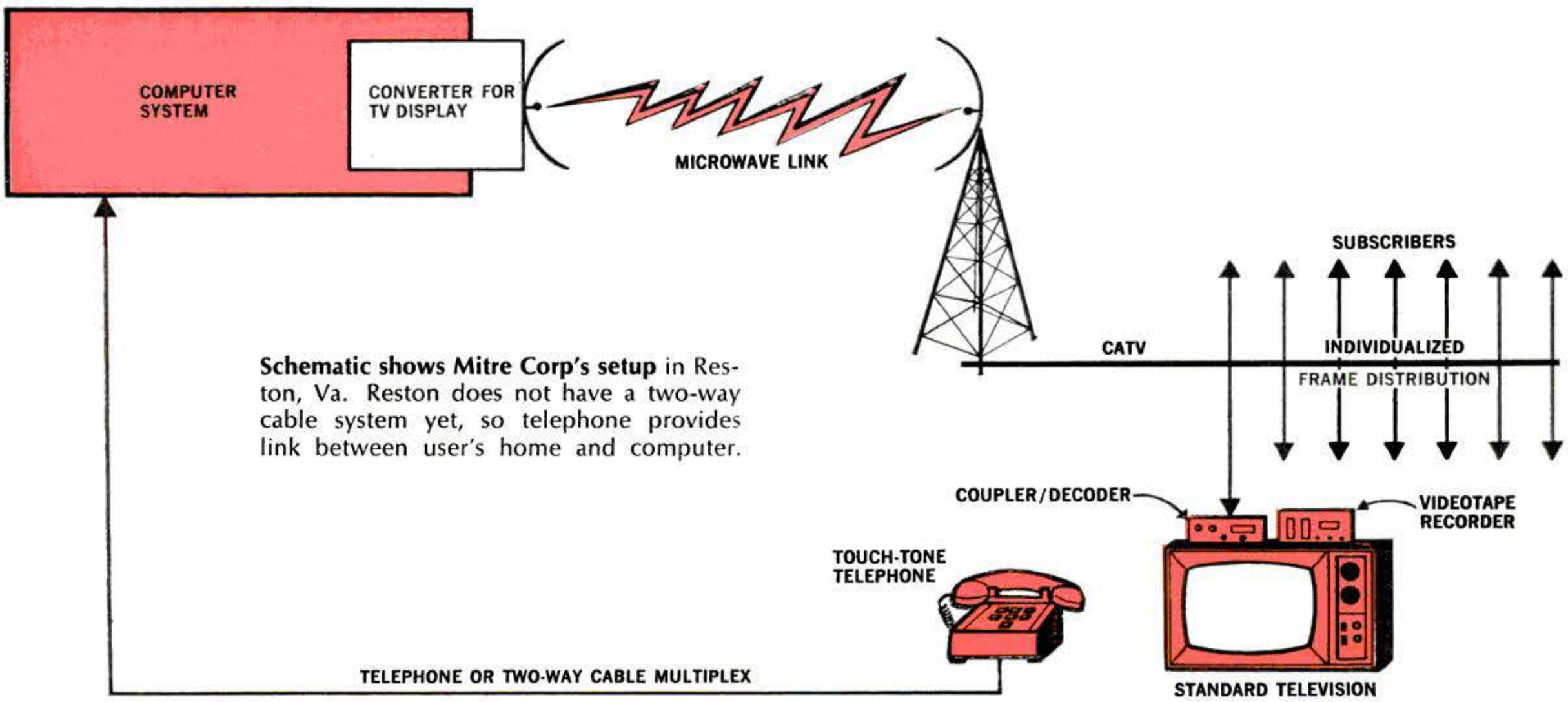

Schematic shows Mitre Corp's setup in Reston, Va. Reston does not have a two-way cable system yet, so telephone provides link between user's home and computer.

The trick is to capture one of those frames and hold it still on the screen—and a while back Jack Marsey, a representative of MITRE, showed me how to do it. "Let's see what time it is," he said picking up the telephone, "and that will give you an idea of how the system works." He dialed the computer's number, then pushed an "X" button, and instantly on the screen flashed a Directory of Services. "Time of Day" was one of them, followed by the code 327, which Marcy fingered on the phone.

Grabbing a TV frame. A clock face appeared on the screen. But it was acting curiously: The second hand wasn't sweeping; it was jumping forward every three seconds. What was happening, Marsey explained, was that the picture of the clock was being transmitted to the set only every three seconds. Whenever the clock appeared in the sequences of pictures, the "frame grabber" grabbed.

The frame grabber, the heart of the system, is simply the video recorder snapping an individual frame. (Each of the 180 frames is coded for the recorder.) The electronic camera would record the clock face as it whizzed by at 1/60th of a second, then continue to play back that picture on the screen until the face came by again, when it would be "refreshed." And the second hand would jump.

"Now something else," continued Marsey. "Let's say you just moved here and wanted an internist. We'll consult the directory, digitally stored in central computer."

He pushed the "X" button again and the directory appeared. Then he punched out the code for "Physicians." On the screen jumped a list of specialists. Marsey requested "internists," and another list appeared, two of them living in Reston. "Let's find out something about Dr. Ross, number two, said Marsey as he punched out yet another code. On the screen flashed the doctor's medical school data, internship and residency, other schooling, and office fees.

"Now we'll make an appointment." He tapped out another code, found five p.m. was available, pressed that number, and received an acknowledgment. The computer automatically sent the patient's name and address to the office.

To capture something permanently, as Marsey demonstrated, you need only snap it with a Polaroid camera.

What might such service cost? When installed in fairly large numbers, monthly rental of the terminal equipment would run from $30 to $40, estimates MITRE, unless the owner owned his own video and switching equipment. (At current prices, a recorder, including portapack and batteries might run $1,400, the brown box about $300.)

With mass production, and not counting the cost of the television (which everyone has anyway), MITRE figures that rental of equipment and average console time usage should cost the subscriber just about as much as his telephone does now. PS

What you should do now

America is now in the process of being netted together in a spiderweb grid of coaxial cable. And once a town is wired, it may be too late for citizens to have second thoughts about their communications future. Commercial operators are more interested in profits than the public's long-term interest, and town fathers, too, often are more interested in an immediate franchise income than in the future.

But a community can't afford to be satisfied with service limited to better color reception and more entertainment. Much more is at stake, because in the future cable probably will be the means of keeping in touch with the world.

Your town eventually—inevitably—will get itself wired up (or expand the system it has now). And you are hereby appointed to ride herd on those involved. Here are a few suggestions:

- Write to the Cable Television Information Center, 2100 M St. N.W., Washington, D.C. 20037 for background material. This nonprofit organization was set up specifically to give cable TV advice.
- Insist that the cable company install two-way capability. FCC regulations often require it, but the rules are vague. As a minimum, specify that bi-directional line amplifiers are installed, and that there be channel capacities, and, if possible, interconnections with other systems.
- To check such technicalities, an engineering consultant should be hired. When a city opens itself to bids, it might require each cable company to advance money so an objective specialist can be retained.
- Stipulate certain community services to be included, such as neighborhood program organizations, colleges, and even controversial groups.
- Check what the franchise fee—often a percentage of gross revenues—is be used for. (Ideally, it should be used for regulating the system.)
- Nail down wiring timetables. Operators might want to skim off the cream of a community, to wire the affluent and easy places first and forget the rest. For community health, insist that plans include everyone, and every part of town.

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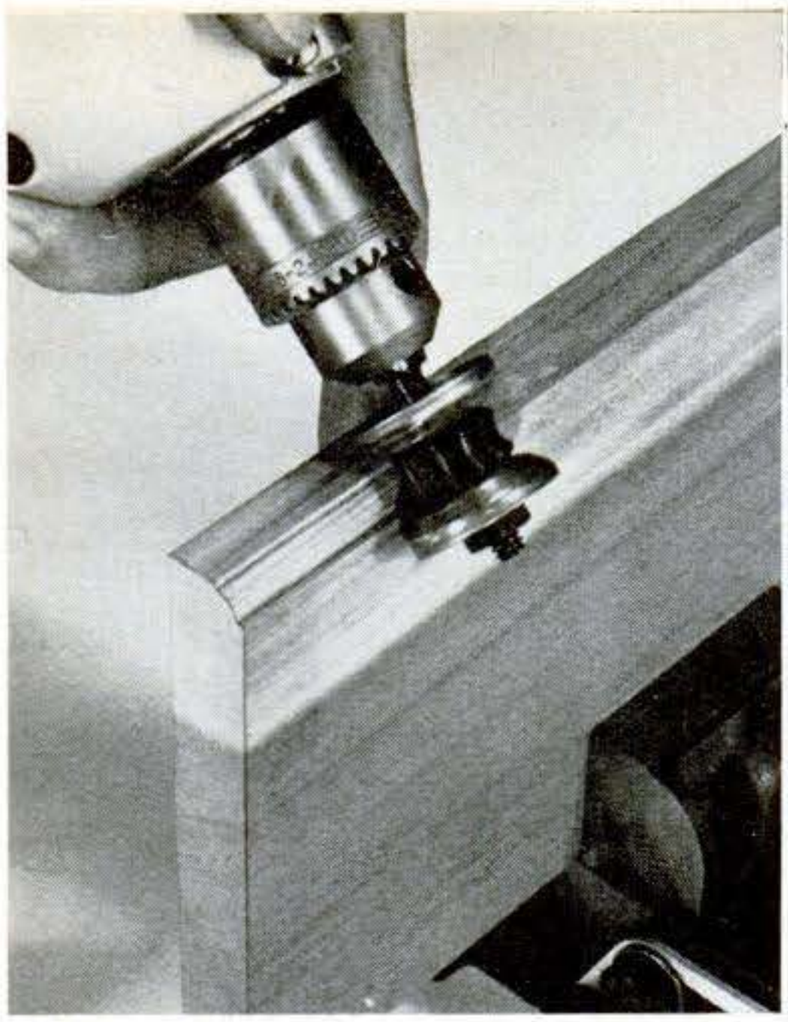
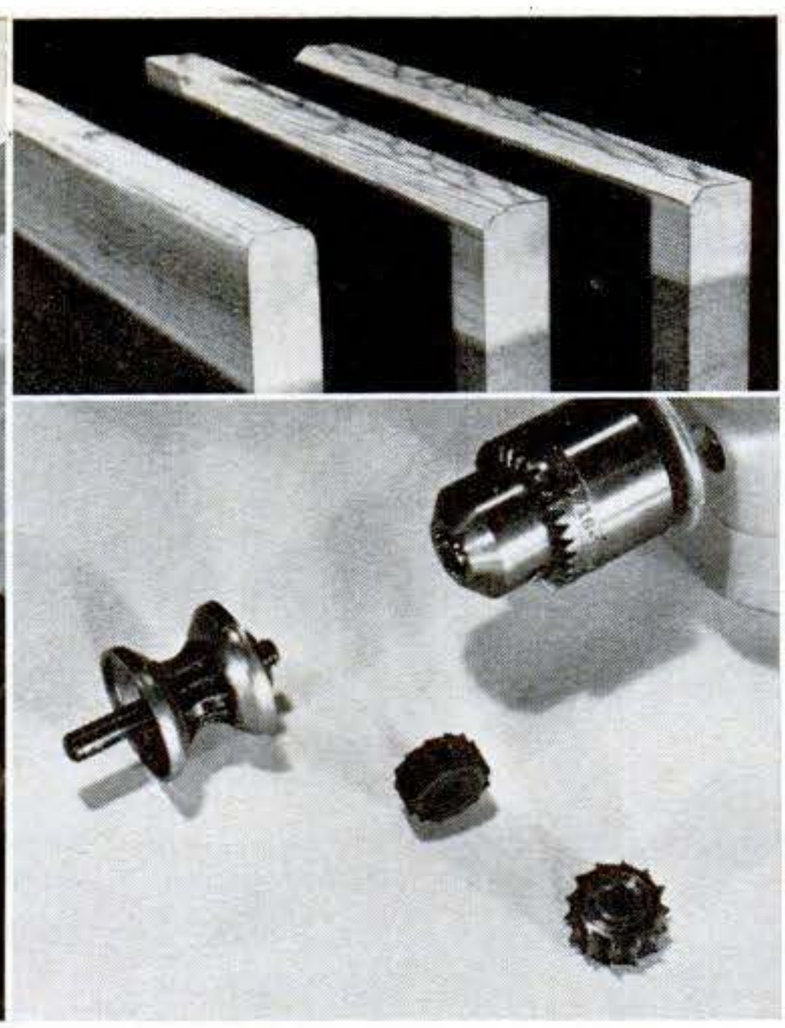


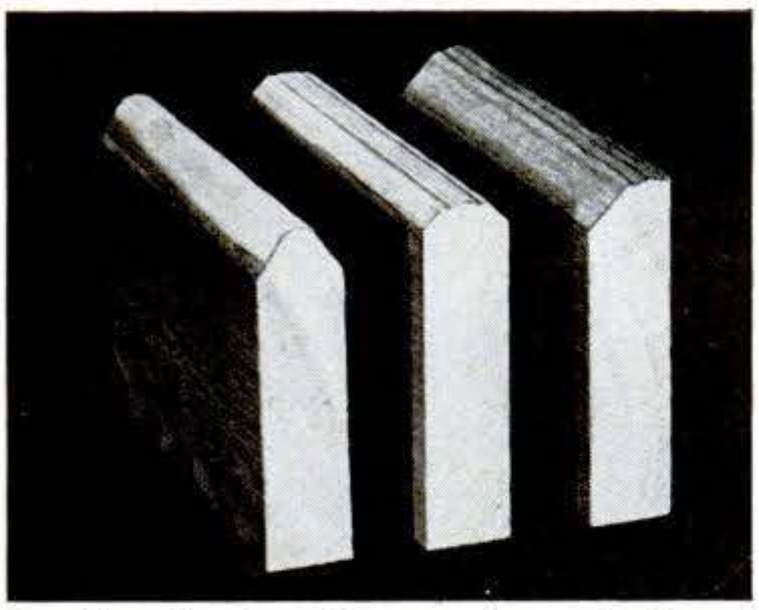
Guide washers automatically position the drill at correct 45-degree angle, just about eliminate possibility of gouging. And since they don't turn, they won't burn wood.



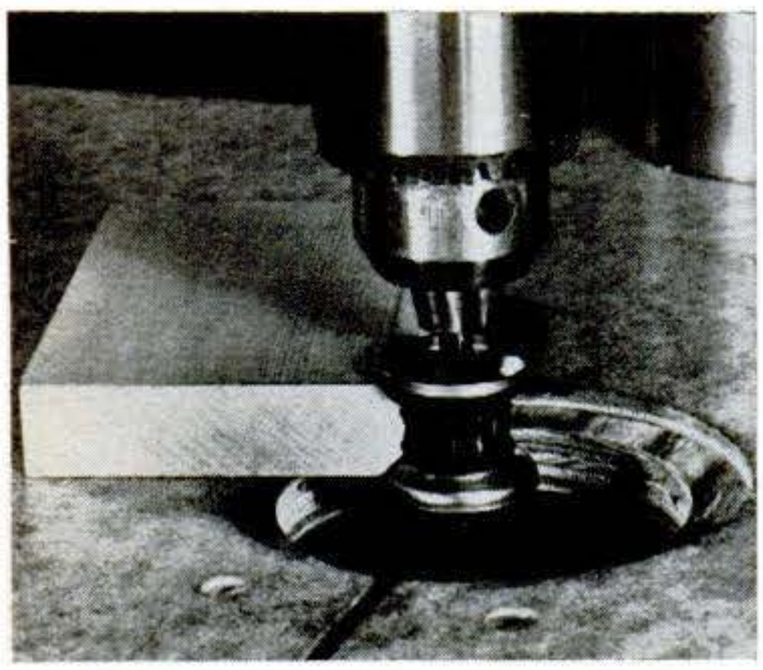
Interchangeable cutters produce the three shapes above. As demonstrated by corner round, no law says you can't shape both corners of an edge. The set is $4.95.

PERSONAL-USE REPORT

Now They've Made Freehand Shaping Easy



Pre-chamfer the edge or edges of a board at 45 degrees and you can hold the cutters square to the stock to produce cuts like those above. Practice on scrap first.



Drill press—with more power and speed—works better than a drill. Here's how De Cristoforo shapes an edge after chamfering corners to accept the guide washers.

This new shaper set for electric drills, from Black & Decker, isn't the first to hit the market; it's just the easiest to use. Interchangeable cutters mount between large guide washers. The cutter turns; the washers do not. This eliminates the friction burn you often get when guide and cutter turn together.

And those guide washers practically dictate the position of the cutter relative to the work. The possibility of human error is low.

Each of the set's three shapers has 12 cutting edges. So if you work at 1000 rpm, you get 12,000 cuts per minute; work at 2000 rpm, and you double that—not bad even though that's for no-load conditions.

I found the cutters do well with a good 1/4" drill on softwoods and some hardwoods. If you're working birch or maple you might want the extra power of a 3/8" drill even though top speed will be less. In any case, you'll always get better results if you feed so the cutting edges work with the grain of the wood. And a preliminary light pass to remove most of the waste is a good idea. The second pass then has less work to do to produce the final shape.

But the cutters should never be babied, any more than they should be forced. Feed at a rate that keeps them working.—*R. J. De Cristoforo*

Automatic

No, the man in the photo at righ is not having his eyes examined. He wearing oversized eyeglasses calle "electro-optic flash-blindness goggles —a kind of super-sunglasses. The protect the wearer by automaticall changing lens density to allow les light if there's an eye-endangerin flash of light, as from an explosion.

Here's how the super-sunglasse work:

When there's a light flash, the sys tem "blinks"—switches the lense from transparent to nearly opaque within 50 billionths of a second. Th wearer is protected as long as the ligh flash persists. When the light level safe for your eyes again, the lenses au tomatically return to the transparen state.

The whole thing is made possibl by a component called PLZT—poly crystaline lanthanum-modified lea zirconate/lead titanate—ceramic. [Se "Ferroelectric Ceramics—New Twis with Light," PS, May 1971.] Pu simply, this ceramic has the ability t "twist" or bend the light when a volt age is applied. Used between two po larizing filters, the ceramic causes th lens to turn opaque or transparen depending on whether the voltage i on or off.

The prototype has a 5.4-volt batter that will power the goggles for abou 200 hours. The 10-ounce goggles wit 1½-inch-diameter lenses are bulk

New Everflash has electronic flash next t viewfinder; on/off switch is at left. Electri eye is next to lens. Focusing is by guess- the camera has no rangefinder.

Instant-Picture

Now there's another new non-Po laroid camera designed to use instant picture Polaroid film: the Berkey 60 Second Everflash. Unlike the recent ly introduced low-price Simpro cam

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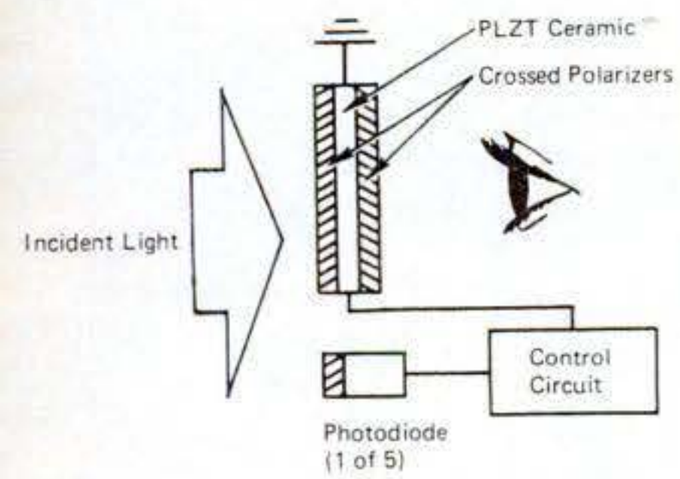
Goggles Prevent Flashblindness

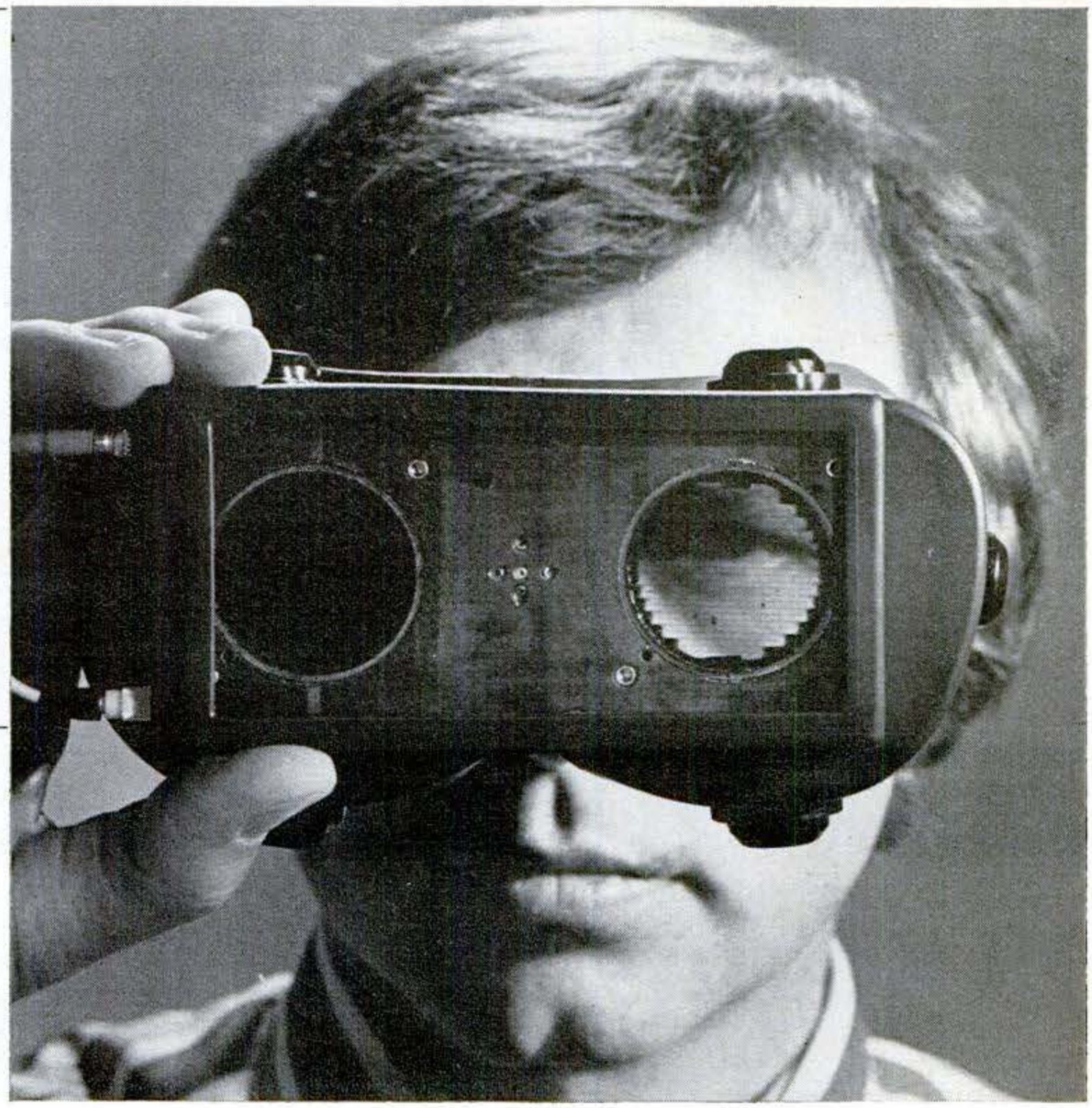


Heart of system is an all-solid-state electro-optic ceramic element sandwiched between two polarizing filters turned 90 degrees to each other (normally blocking light). When the system is turned on, the ceramic element "twists" the light, allowing it to pass through; now wearer can see. When a flash of light is detected by a diode, the voltage is removed (system "off"), and light is stopped by filters.

and cumbersome, but they haven't been fully miniaturized.

Applications? Yes, plenty. Wearers can use them for protection against nuclear flashes at test sites and for welding and metal working.

The ferroelectric ceramic may also have uses in electronic shutters for photography and other areas where "optical switches" or "light gates" are needed. The goggles were developed by Sandia Laboratories, Albuquerque, N.M.—*Doug Garr*



Prototype goggles above show right lens in "on" mode; left lens in "off" mode (for demonstration). If light level is dangerously high, lenses switch off.

amera With the Flash Built In

era [PS, Nov. '72], the Everflash offers deluxe features:

- Automatic film exposure.
- An electronic shutter, with speeds from 1/500 to 10 seconds.
- A built-in electronic flash, complete with light and sound effects—blinking ready light and beeper—to indicate when it's ready to go.
- Flash-coupled focusing—the lens opens or closes as you focus, to admit more or less light, in accordance with the distance to the subject.
- Dual-format capability—the camera takes both the standard rectangular film (Type 107 for black and white, 108 for color) and the less-expensive square-format Type 88. Both film sizes can be used interchangeably, and the camera—including the field in the viewfinder—adjusts automatically to the format.

The big news, of course, is the built-in electronic flash. The Keystone Division of Berkey, which makes the camera, has been building electronic flash into instant-load (Instamatic-type) cameras for quite a while(would you believe they're the world's largest producers of electronic-flash units?), so it was a natural for their new 60-second camera. It gives you no-effort, no-cost flash, especially welcome in marginal picture-taking situations—outdoors, for example, to fill in shadows on faces—where you may be reluctant to spring for a flashcube.

The Everflash comes in two versions: Model 800, which uses three standard AA (penlight) batteries and goes for $79.95, and Model 850, which is rechargeable and costs $99.95.

Is Polaroid worried about all the competition? "Not as long as those cameras keep burning up our film," says a Polaroid official.—*Everett H. Ortner*

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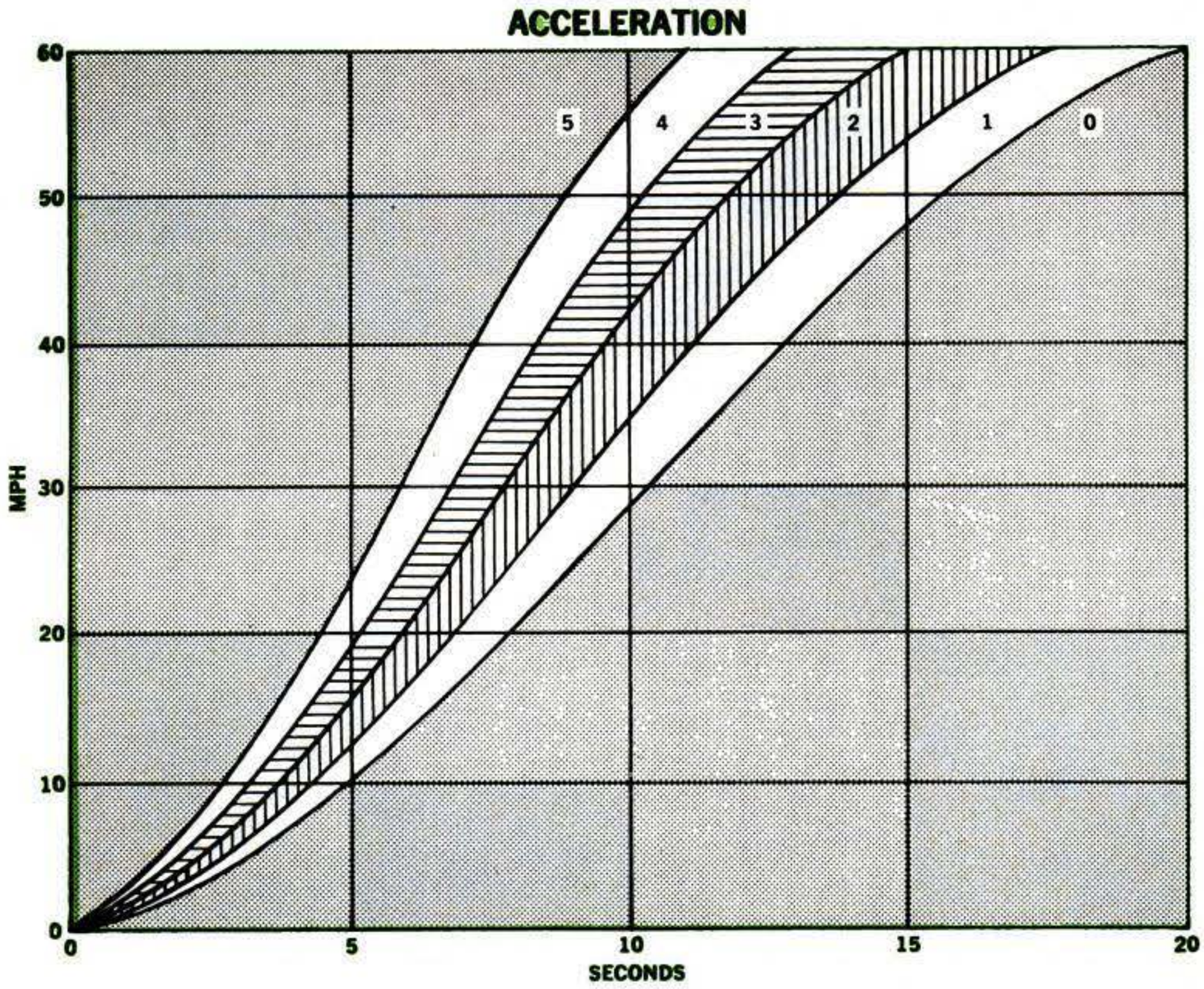
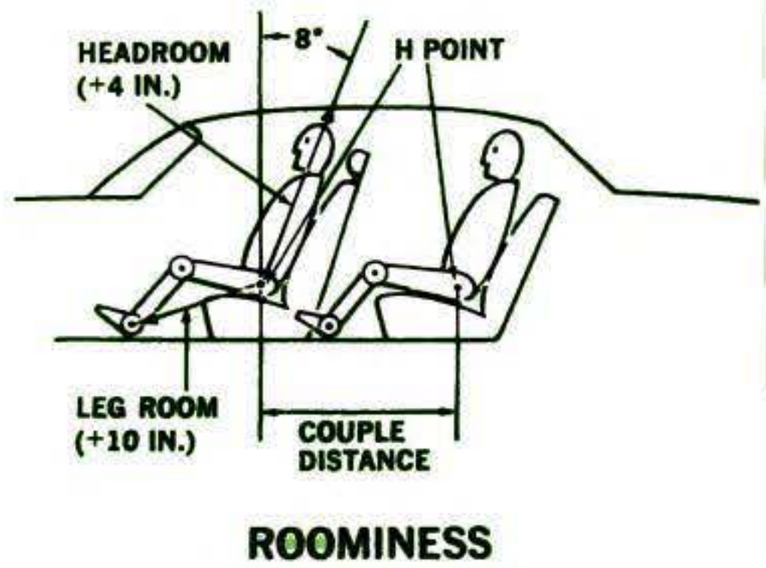


TERMS AND DEFINITIONS USED IN OUR RATINGS

The graph at left shows how points are allocated for acceleration from standstill to 60 mph. The curves for the ride-comfort test at right have no numbers on them, since this test is still in the formative stage. But you can see what we're aiming for. The other sketches show simple measurements. How they count in ratings is explained in article.



PS Begins a New Rating System

Going by the numbers will make it easier for you to compare the test cars and pick your next one

This issue marks a great change in the PS Norbye/Dunne Report (page 30). We are expanding our test program. We are also adding a new way to express the test results: a numerical rating system that will allow us to show more clearly how each vehicle ranks in major areas on which you base your buying decisions.

We have chosen 10 such areas—seven based on tests, three based on dimensions. Parameters for the rating system are based on our six years' experience and comprehensive tests of over 250 vehicles. Points allocation is based on numerical data only, without subjective judgments.

The seven test areas are: acceleration, braking, handling, maneuverability, quietness, ride comfort, and fuel economy. The non-test evaluations concern visibility, roominess, and ease of entry/exit.

A look at our ratings for each car will give you a quick answer on how good or how bad they are in each respect. The ratings will enable you to make valid comparisons more quickly.

The ratings do not take into account all features of a car. *You cannot use our ratings as the sole basis for choosing a car.* You've got to examine the car for yourself before you decide. What we give you is a simple yardstick for rating the cars in areas you cannot easily check out yourself.

How to use the ratings. We don't add up all the points, and we don't think you should. Select the areas of performance or design that are most important to you, and see how we rate them where it counts. We'll continue to report on interior equipment, service accessibility, trunk space, and liftover height, but we won't give the cars ratings in these areas, for there's no equitable way to set numerical values for them. And only you can judge the cars for styling, color, and suitability for your own particular purposes.

We have evolved a rating system with a point scale from zero to five for both test and non-test evaluations. Performance above a certain level gets maximum points. Below a certain level, it rates zero. It doesn't matter how far above or below the limits—what you care about is the area between excellent (5) and a nonpassing grade (0). The limits were set with the typical American traffic picture in mind.

Acceleration. We use the 0-60-mph time as the basis. We think 20 seconds represents the slowest acceleration consistent with safe highway driving, and that 11 seconds is ample, consistent with safety and comfort. The graph above shows how the area between is divided.

Braking. We think the minimum stopping distance after warmup best reflects overall brake performance, taking into account all main aspects of braking (weight transfer, brake-force distribution, and fade). We give zero points to any car that needs more than 210 feet to stop from 60 mph, and five points to all cars that stop in 125 feet or less.

Handling. High-speed handling precision is rated according to the car's speed in our double lane-change test. We set the five-point limit at 65 mph, which is close to the optimum for a full-size car. We set the zero-point limit at 52.5 mph. In our experience, cars that cannot make the test at that speed have serious deficiencies in suspension, steering, weight balance, tires, or a combination of all these factors.

Maneuverability. Our low-speed slalom has proved to be a good test of the

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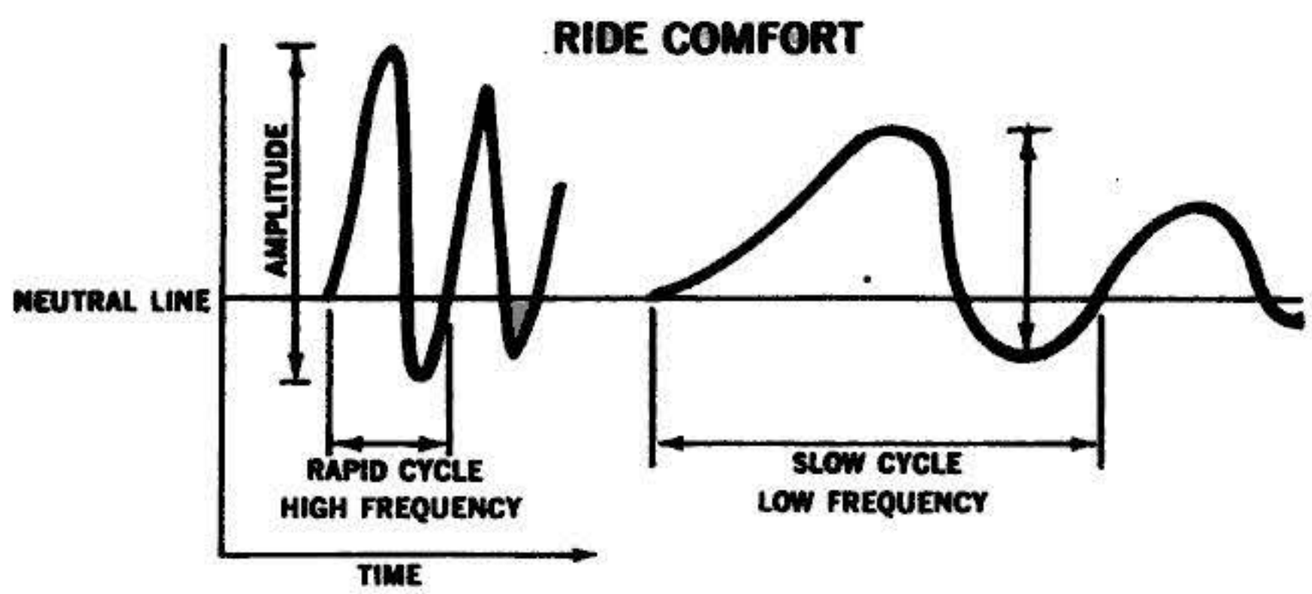
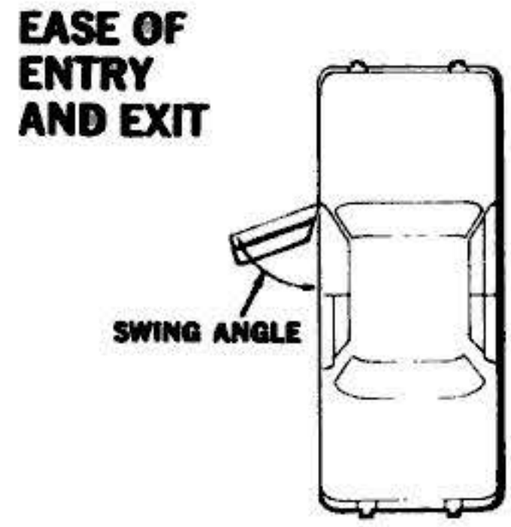
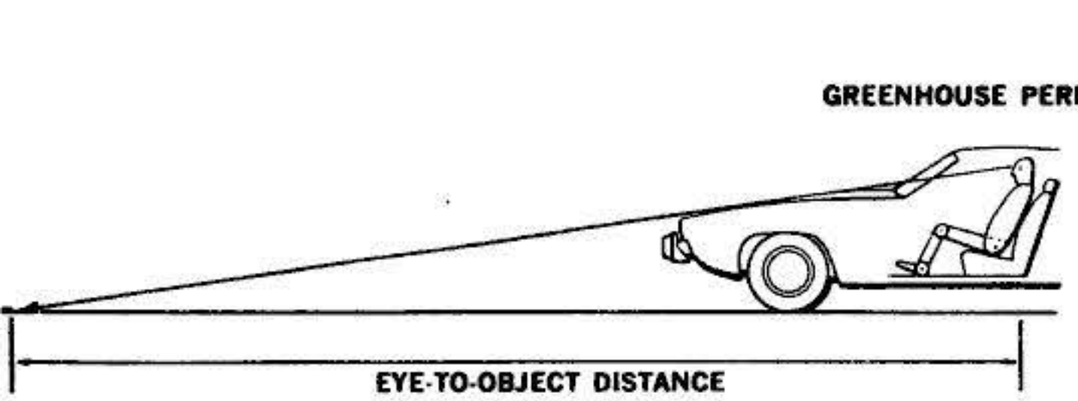
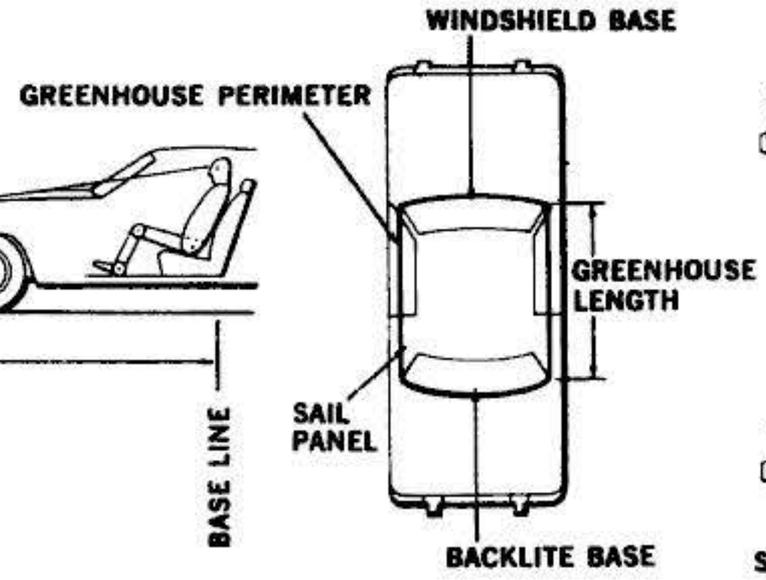
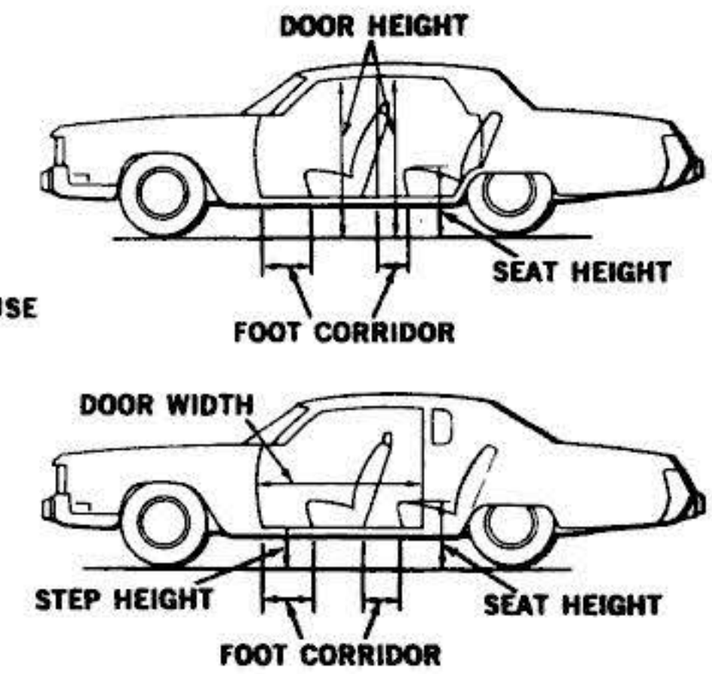






FORWARD VISIBILITY





for the Cars We Test

By JAN P. NORBYE / *PS Automotive Editor*
and JIM DUNNE / *PS Detroit Editor*

combined steering system, including turning circle, steering ratio, returnability, front-wheel geometry, and tires. The five-point limit is set low enough to be achieved by a large car (26 mph). Zero-point limit is 22 mph.

Quietness. Ratings for interior noise are based on tests at 30 mph on smooth and on rough surfaces, and at 60 mph on a smooth road. Our formula gives 50-percent weight to the high-speed reading. We set the zero-point limit at 70 dbA, the five-point score at 62.5 dbA or better.

Ride comfort. This test is still in the experimental stage [PS, Sept. '72]. Until we have more experience with test methods and equipment, we'll give you a tentative rating only—denoted by parentheses in the rating chart. So far, our results seem to conform to subjective impressions of ride comfort. How do we test? Our tape records vertical accelerations in a sensor (an accelerometer) on the front seat. Sensor deflections vary in amplitude and frequency, and total duration varies from car to car. By multiplying the amplitude by the total duration, then dividing the product by the frequency, we get a ride-discomfort index that can be used as basis for a rating. The scale is still tentative. We'll keep you abreast of our progress as we learn more about ride measurements.

Fuel economy. We test gas mileage at a constant 45 mph, which is representative of average traffic conditions, yet fast enough to let aerodynamic drag play its part. The course has enough curves to take full account of power losses between tire and roadway, and enough hills to let gear-shifting play its part for cars with weak low-end torque. The zero-point score was set at 12.5 mpg to represent the norm for a large family car, and the five-point limit at 27.5 mpg to represent the expectations of the economy-car buyer.

Roominess. Our formula gives a numerical value to total interior space, based on head room, leg room, hip room, and couple distance (see sketch above). SAE standards are used for all dimensions. Trunk space is not included; for station wagons, cargo space is kept separate.

Visibility. Our rating formula is based on measurements of the two principal obstacles to a clear view: hood lines restricting forward visibility, and sail panels causing rearview blind spots. Forward view is measured by establishing the shortest distance at which an object on the road ahead is visible from the driver's eye level (see sketch). As an index of rear visibility, we establish the ratio between the glass area and the total "greenhouse" surface (see sketch).

Entry and exit. Our formula includes a complex analysis of all factors that influence ease of entry and exit: door size and swing angle, seat height (above ground level), step height and sill obstruction, tumblehome (door-glass intrusion into doorway gap—see sketch), and foot corridors front and rear. The formula takes account of differences between two- and four-door bodies and puts a just penalty on two-door models.

When you get to the specification tables, you'll find we have added more information about the steering and brake systems. Also we are including the front/rear weight distribution (with the car in curb-weight condition—ready to go, with full tank, but no load or driver).

The layout of the report has been revised to make it easier for you to find the full answers to your questions. Test information has been grouped so that all related data is presented together. We think you'll enjoy the Norbye/Dunne Report more than ever, and will continue to bring further improvements in our testing, evaluation, and reporting. PS

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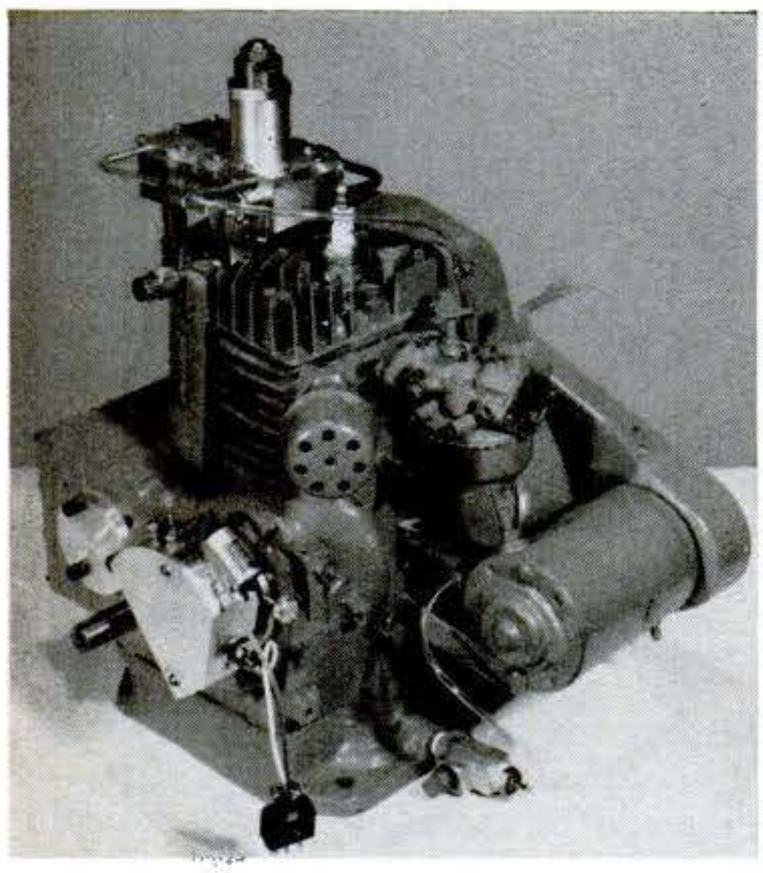
HYDROGEN: Fuel of the Future?

By ALDEN P. ARMAGNAC

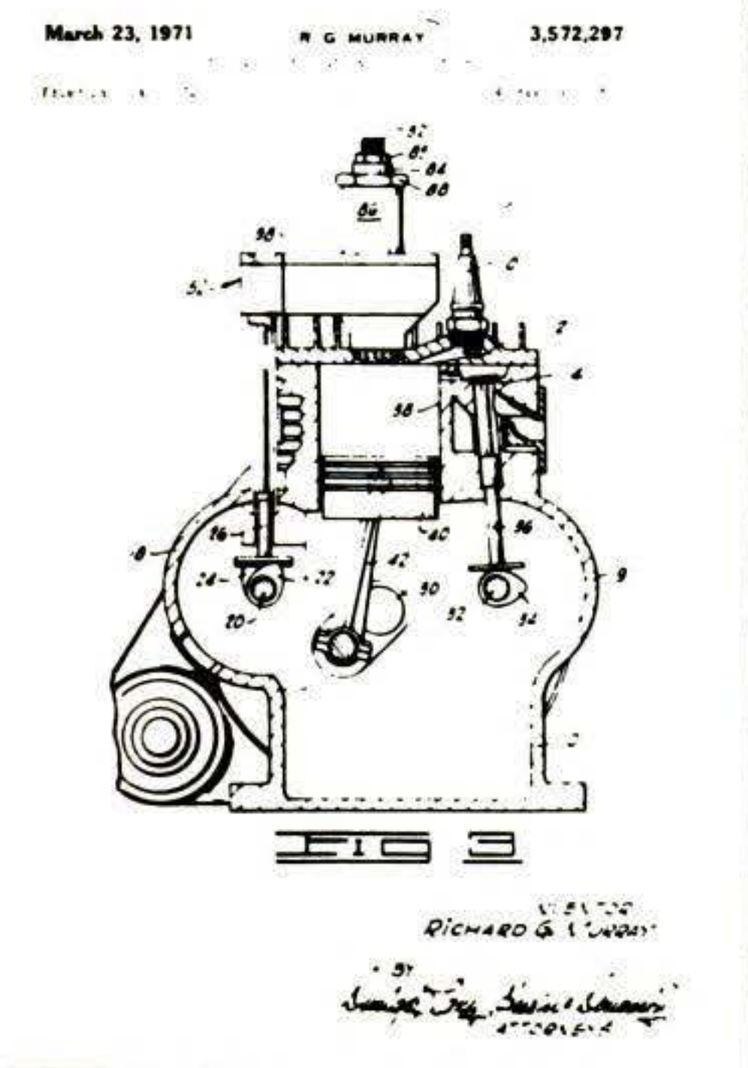
Teamed with atomic power, element No. 1 might be the prime answer to air pollution and our "energy crisis"

It will power your car, stoke your furnace, cook your dinner, and fly you six times as fast as sound. That's the promise of hydrogen—the space-age fuel that propelled our astronauts to the moon.

Familiar to schoolboys as the H in H_2O, hydrogen packs the most energy per pound of any fuel known. Normally it's a gas—invisible, odorless, flammable. Chilled to −423 degrees F., it becomes a watery liquid—made in quantity for U.S. space rockets since early in the 1960s.



Internal-combustion engine using hydrogen fuel, at Oklahoma State University, has patented new design below. A separate injector for hydrogen gas (protuberance at top) solved problems of knocking and backfiring with the exotic fuel.



Cleanest fuel there is, hydrogen burns to pure water. It will bring us a spick-and-span new world.

Because hydrogen is man-made, it can be burned when we run out of natural gas, oil, and coal.

Not only is hydrogen one of many and varied answers to our oncoming energy crisis that are currently being explored—including fusion, solar and geothermal power, and other exotic sources of energy. It has the special appeal of offering something that other approaches lack, a future fuel *in portable form.*

All of a sudden, engineers are waking up to hydrogen's attractions as a universal fuel. Just within the last year or two, they're fascinating technical-society meetings with what they see ahead:

Today's fuels, gasoline and natural gas, will mount in cost as they get scarcer. A day will come when mass production of low-cost hydrogen, at tomorrow's atomic-power plants, will make it competitive in price. That will be the break-through to the Hydrogen Era.

Hydrogen—teammate of A-power. Atomic power stations, generating more than half of our electricity by the year 2000, will hopefully give us plenty of it. But you want energy in other forms, too.

At home, only 15 percent of the energy you consume is electric. A gas main or a fuel-oil truck brings you the energy for cooking or heating. Your car demands portable fuel.

So atomic electricity and hydrogen fuel will make a perfect team.

During off-peak hours when electric demand slackens, our coming A-plants' power can be diverted into electrolytic cells at the site. Passing electricity through water breaks it down. Off comes abundant hydrogen gas—and oxygen gas, a free by-product. It isn't the only way to make hydrogen, but it produces the purest. Pipelines, quite possibly the very ones now carrying natural gas, will distribute the hydrogen fuel countrywide.

What do we do with the oxygen we get for free? Some propose using it to restore polluted rivers, or selling it to steel plants. Others foresee an ultimate "twin-pipe system" distributing hydrogen and oxygen to be burned together in power plants of ultra-efficient design.

When will it all happen? It may take "50 years or so," by one sophisticated estimate, for the Hydrogen Era to reach full flower—but even today a beginning's been made. Pioneering steps have already created hardware for hydrogen fuel—vehicles, engines, home appliances. A look at it will show how far technology has come

A hydrogen car: Engineering students of University of California at Los Angeles revamped this 1972 Gremlin to burn hydrogen. Two cylinders of the gas, compressed to 6000 pounds' pressure, gave 50-mile range for recent contest's trials.

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Cleanest fuel there is: Snow-white cloud of steam (pure water) spews from exhaust nozzles of 21-million-horsepower hydrogen-powered vehicle—Saturn V moon rocket's second stage, here being test-fired at NASA's Mississippi Test Facility.

and the major problems that remain.

Hydrogen for your home. When your gas company switches from natural gas to the new fuel, hydrogen will enter your home. It will bring chimneyless furnaces, flueless heaters, and flameless kitchen ranges.

Your home won't need a chimney, nor your hot-water heater a flue, to dispose of noxious fumes; with hydrogen gas as the fuel, there aren't any.

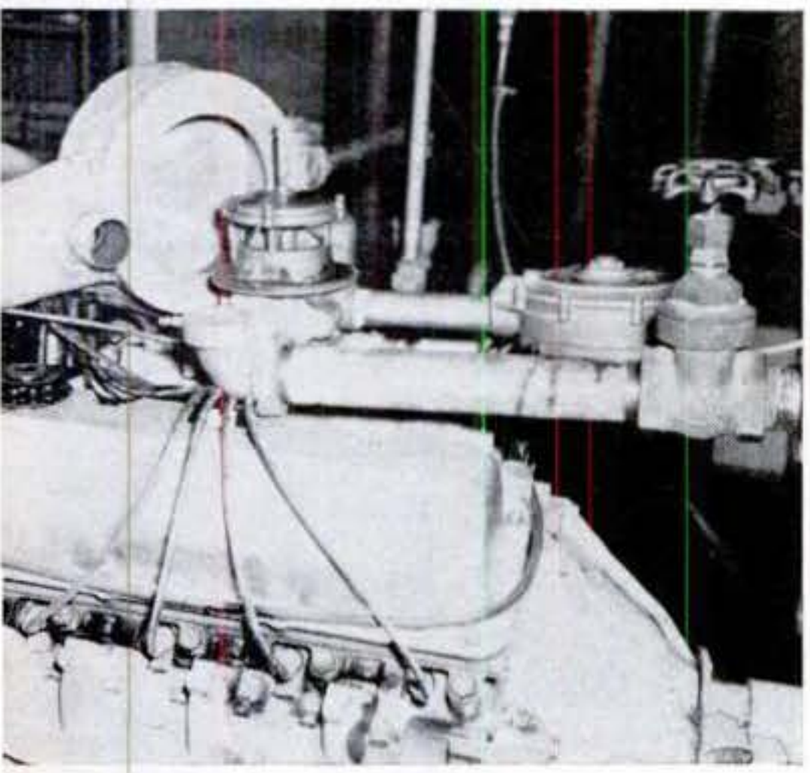
Your house-heating system will gain up to 30 percent in efficiency. Since the combustion product is pure water, only enough of a hydrogen heating plant's exhaust need be ducted outdoors to avoid excessive build-up of humidity, when coldest days keep it running steadily. Otherwise no heat will be lost to warm the great outdoors at your expense; and humidification takes care of itself.

"Central" heating becomes needless. Each room can have its independent heater, favorably located.

Today's gas range will become an antique. The burners could be adapted; it was done for a new fuel, decades ago, when we went from manufactured gas to natural gas. But something better will be waiting.

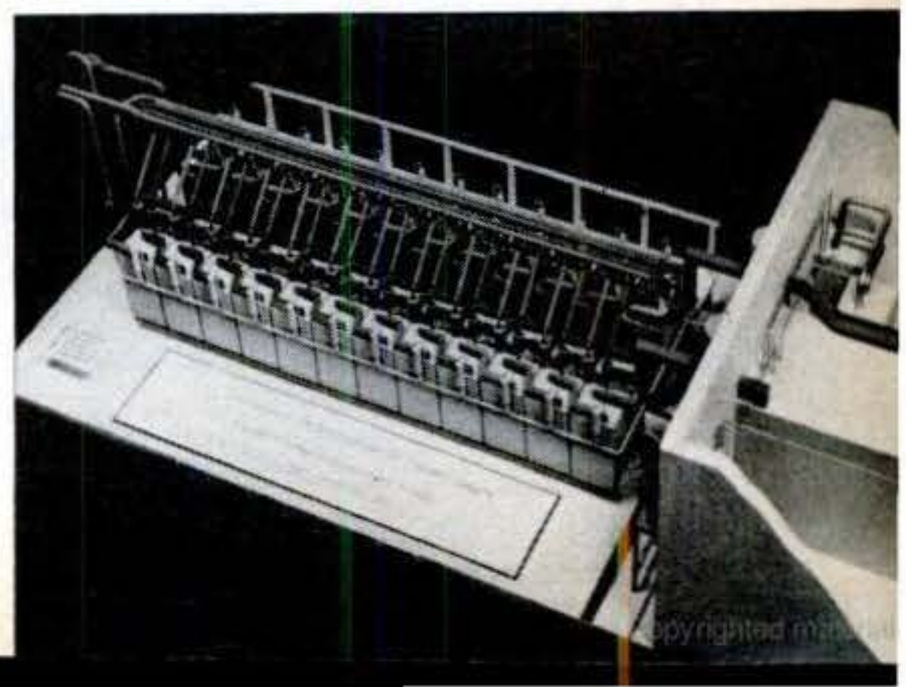
American Gas Association researchers have developed and displayed a catalytic gas-stove burner with an unprecedented low-temperature range. From full heat it can be turned down to such gentle warmth, that a cooked dinner can be parked in a tray right on the stove top, and kept ready to serve until mealtime.

Continued

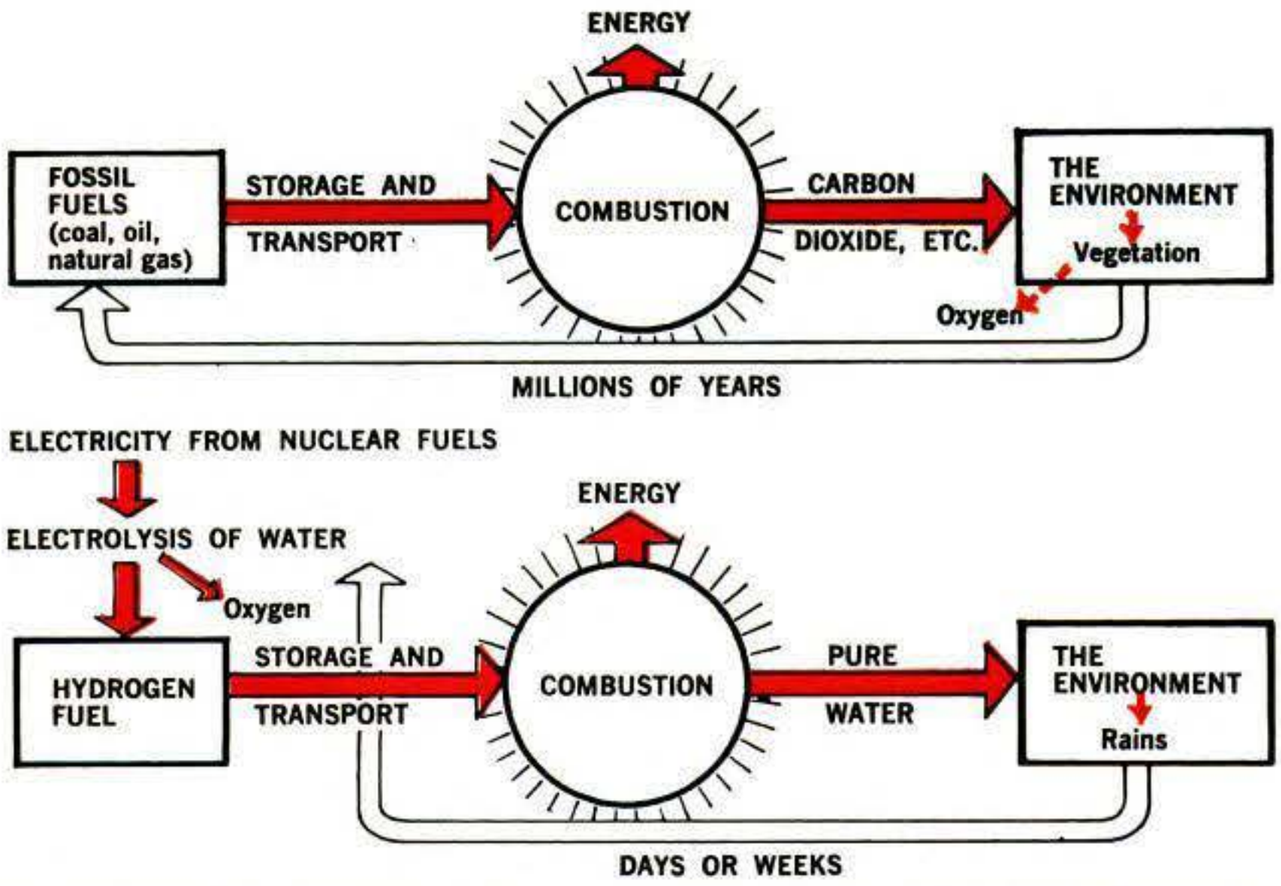


UCLA car's engine has carburetor, air intake, and hydrogen regulator at top left. Pipe (unconnected) recirculates exhaust.

Electricity makes hydrogen from water. "Packaged" plant, above, could be type used at auto service station of the future. Below is model of big San Francisco plant now operating. (Photos from The Electrolyser Corp. Ltd., Toronto.)

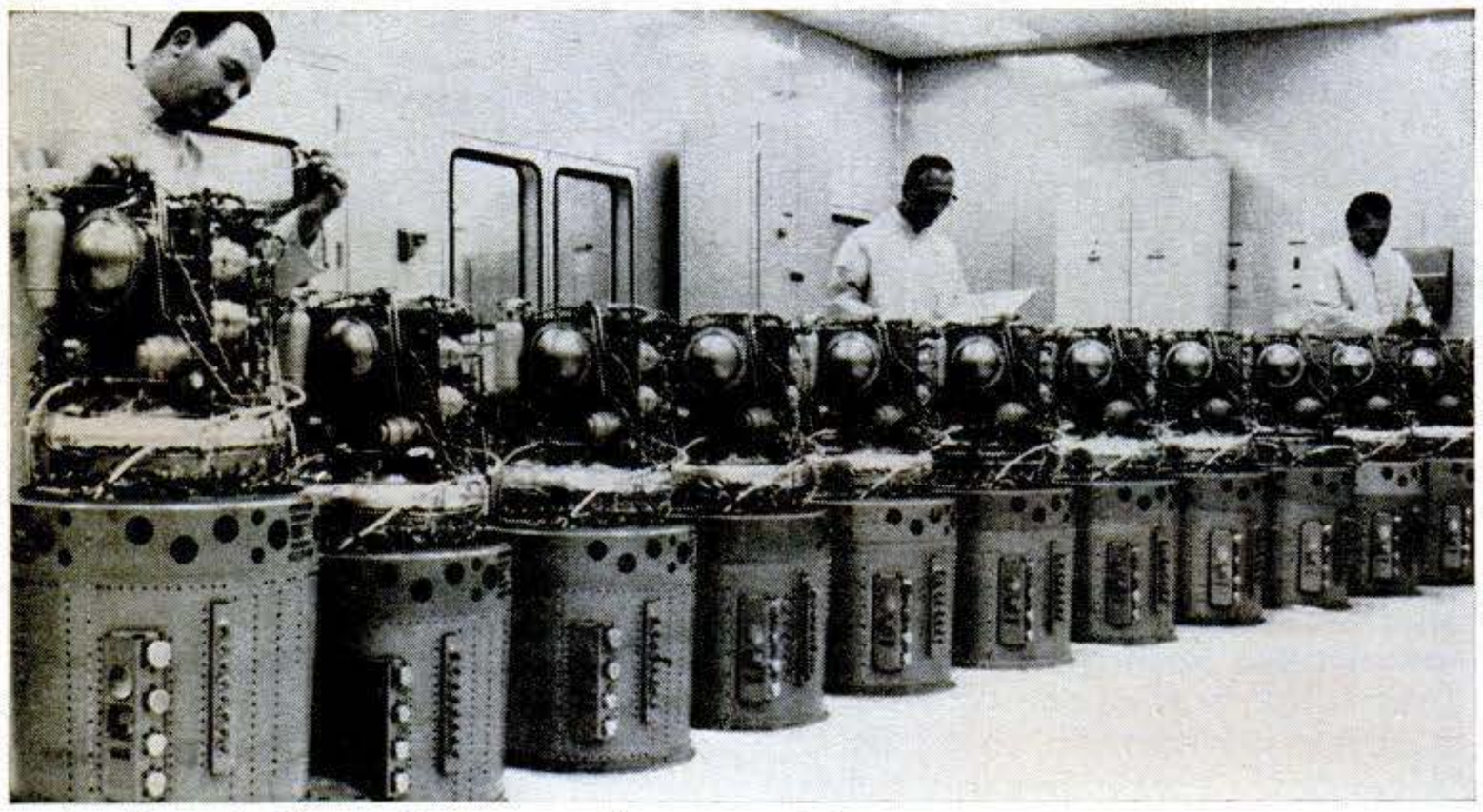


Man-made hydrogen from water promises an extra-clean fuel for homes,



Diagrams compare the story of fossil fuels, and hydrogen fuel, in environment. We're exhausting our oil, gas, and coal because nature takes eons to replace them (upper chart). The water from burning hydrogen fuel, made at nuclear plants, will go right back to nature, ready to yield the fuel again (lower chart).

Hydrogen-fueled airplane on the way? NASA technician holds wind-tunnel test model of future Mach 6 transocean passenger plane. Air-breathing ramjet engines of craft would burn liquefied hydrogen, carried in tanks in interior of plane.



Fuel cells made for Apollo spacecraft generate two kilowatts of electric power apiece, by reacting hydrogen and oxygen. Product of the reaction is water, so pure you can drink it—and astronauts do. Now fuel cells look promising for uses on earth.

The revolutionary burner is a porous ceramic plate, oblong or what you will, containing a catalyst. Gas mixed with air burns *inside* it. No flame appears above its smooth surface; it can set nothing afire. Gasoline poured on it won't ignite.

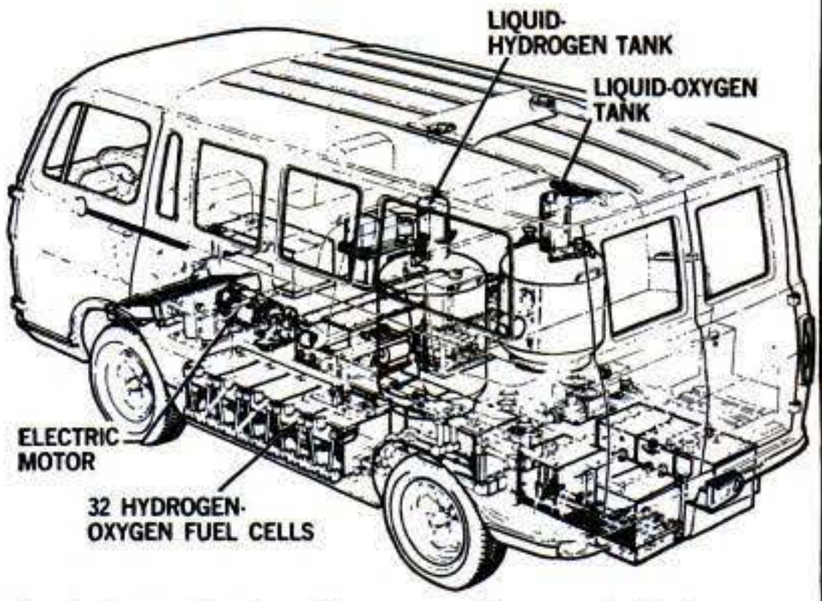
Why don't we have it now? Its catalyst won't light today's natural gas; currently it would need a pilot light or electric preheating. Its ideal fuel, hydrogen, will eliminate this complication, making it practical.

How about home power tools? An experimenter has built a hydrogen-fueled lawnmower, it's reported.

Is hydrogen safe? Not for an airship's lifting gas, the Hindenburg-fire disaster of 1937 spectacularly showed. But experts rank hydrogen high in safety among fuel gases. Extreme lightness impels it to take swift leave of any vented space, rather than form dangerous accumulations as heavy gases and gasoline fumes can do.

Supercold *liquid* hydrogen has a special hazard: danger of severe, even fatal frostbite from it, if it's spilled. Most agree it's for handling by trained personnel only.

Hydrogen cars. Clean-air cars of tomorrow vied last August in an Urban Vehicle Design Competition at Milford, Mich. ["The Race to Design the Ideal Urban Car," PS, Nov. '72]. Overall first-place award for internal-combustion entries went to a car running on hydrogen fuel. Five engineering students of the University of California at Los Angeles built it from a



Prototype fuel-cell car on the road, below, is General Motors' experimental Electrovan. It is powered by hydrogen-oxygen fuel cells that deliver 32 kilowatts of power to electric motor (above). Tanks hold liquid hydrogen and oxygen.

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cars, planes, spacecraft

1972 Gremlin and a Ford "Boss" motor, which they remodeled to burn hydrogen gas instead of gasoline.

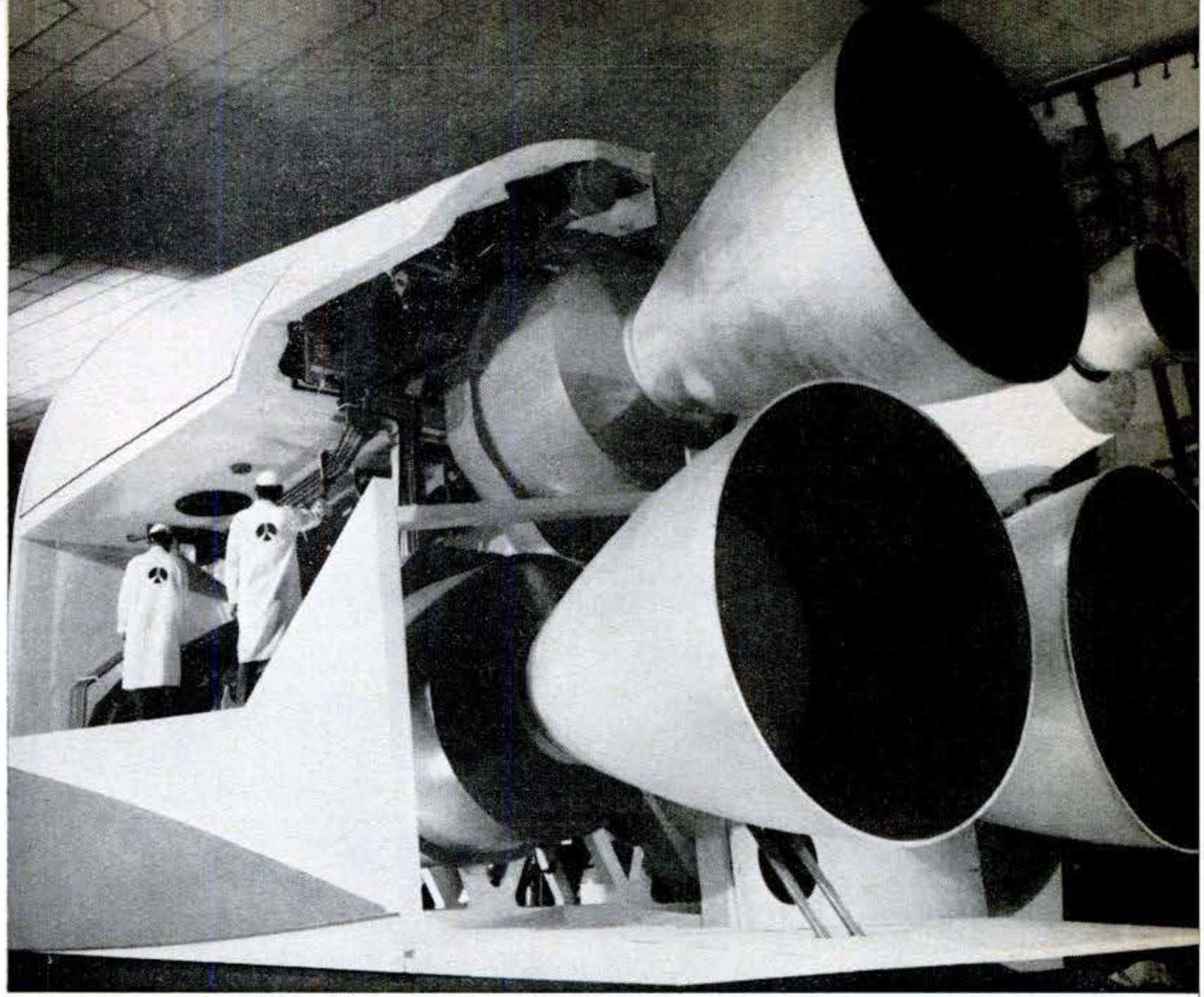
Their hydrogen car is one of nearly a dozen that enthusiastic pioneers have put on U.S. roads in the last two years in Perris, Calif., Hollywood, Fla., Provo, Utah, and elsewhere. Sometimes there's a two-man crew, a "pilot" at the wheel and an "engineer" tinkering with the fuel controls. The experimental vehicles illustrate many a problem still to be solved before there'll be a hydrogen-powered car in your garage.

How will cars carry this fuel? UCLA's prizewinner used hydrogen gas compressed to 6000-pound pressure, in two bulky 480-cubic-foot cylinders. A shelf for them had to usurp some of the passenger-seat space. They gave only 50-mile range, just enough to complete one of the competition's test runs before refueling.

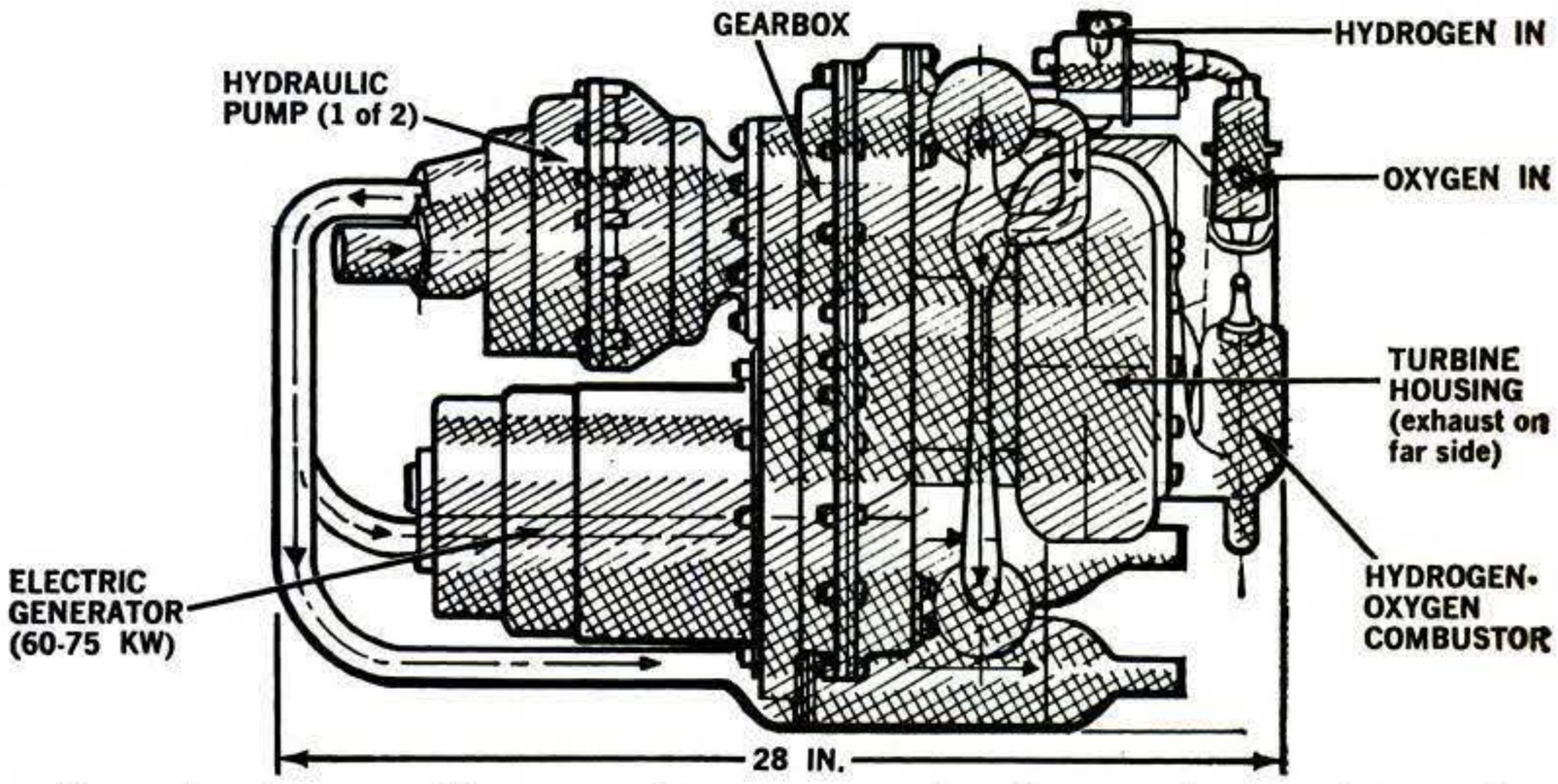
California experimenters have run a car on liquefied hydrogen—much more compact, but still bulkier than gasoline. For the same range, the fuel tank would need to be nearly four times as big. It could go behind a car's rear seat at the expense of some of the trunk space.

Liquid hydrogen raises complications. The tank must be something special, to keep the contents cold—a Dewar container, essentially like a Thermos bottle. However, about two percent of the liquid would boil off daily. To prevent pressure build-up,

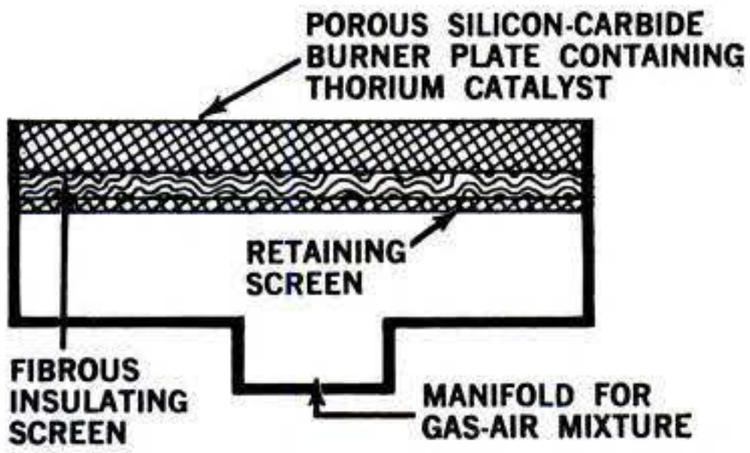
[Continued on page 128]



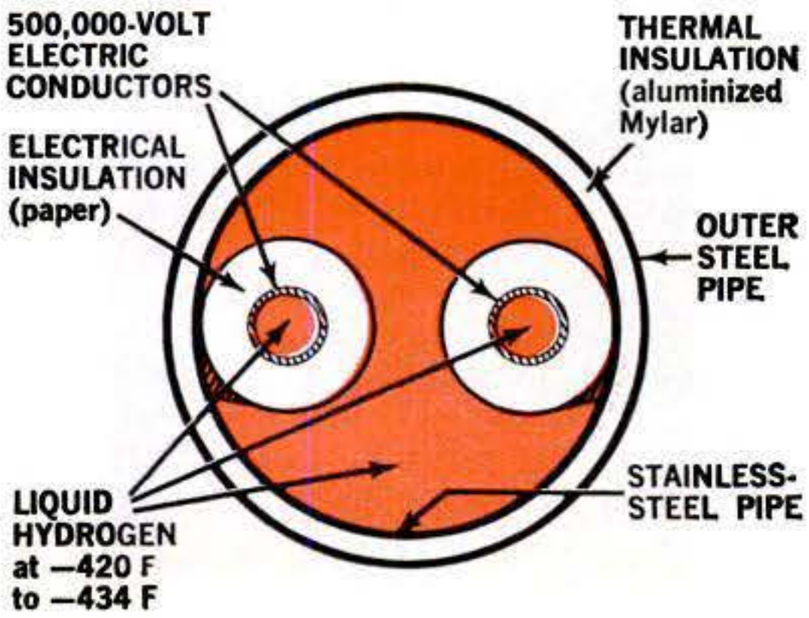
Mighty hydrogen engines of coming Space Shuttle are displayed by mock-up of orbiter craft's after end in North American Rockwell photo. Together with booster stage that drops off at 25-mile altitude, they propel the "spaceplane" into orbit.

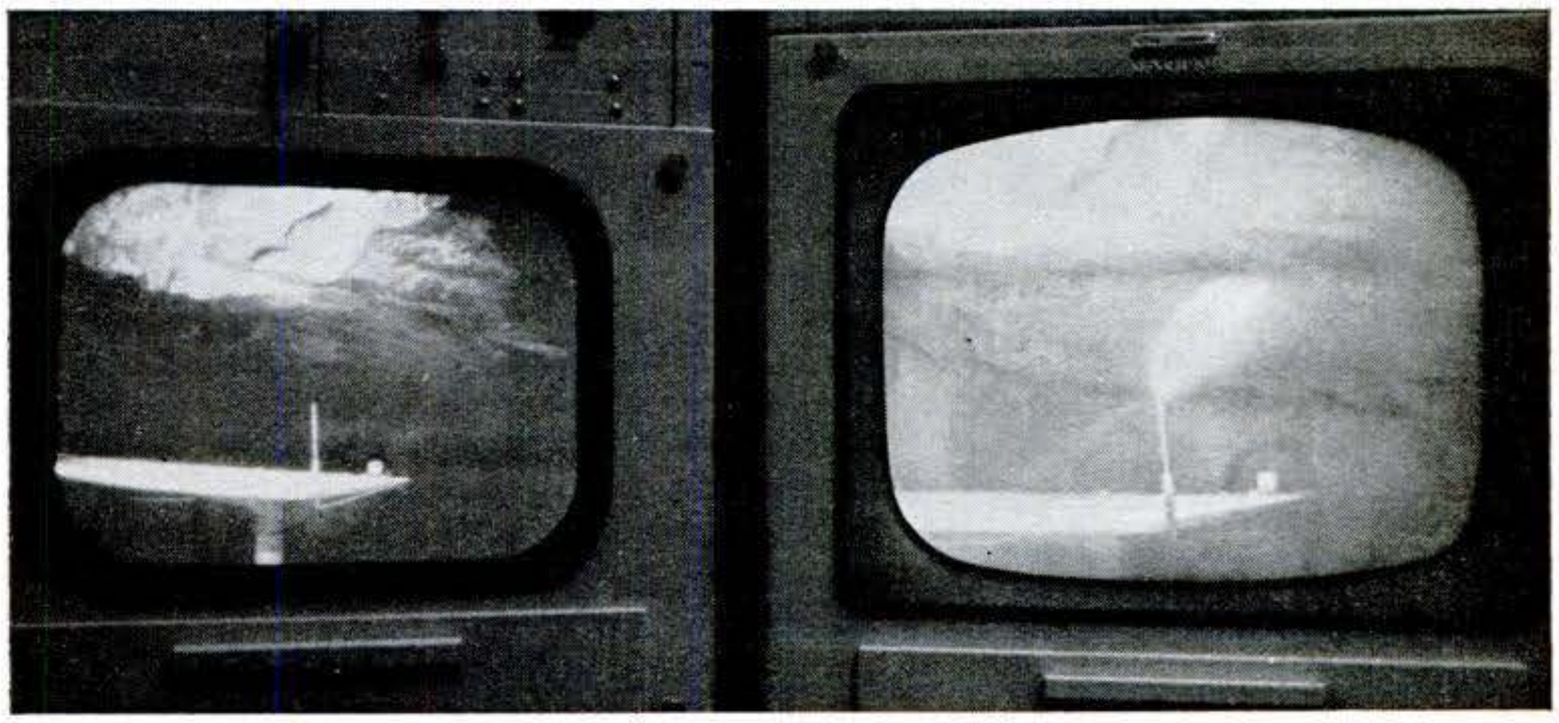


Hydrogen-burning gas-turbine set, only 28 inches long, was designed for NASA as a possible source of electric and hydraulic power aboard Space Shuttle orbiter craft. For gas turbines of all sizes, hydrogen has been called an excellent fuel.



New-type catalytic gas-range burner, for kitchens of the future, will be made practical by hydrogen for homes. Below, proposed combination pipeline carries both liquid hydrogen and electricity in cables that it chills to low resistance.





Hydrogen gas for home may need additive to show when it's lit—since low-pressure flame is almost invisible. Photos in Rocketdyne lab show how burning jet looks to ordinary TV camera, and to one sensitive to infrared rays (radiant heat).

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What's New

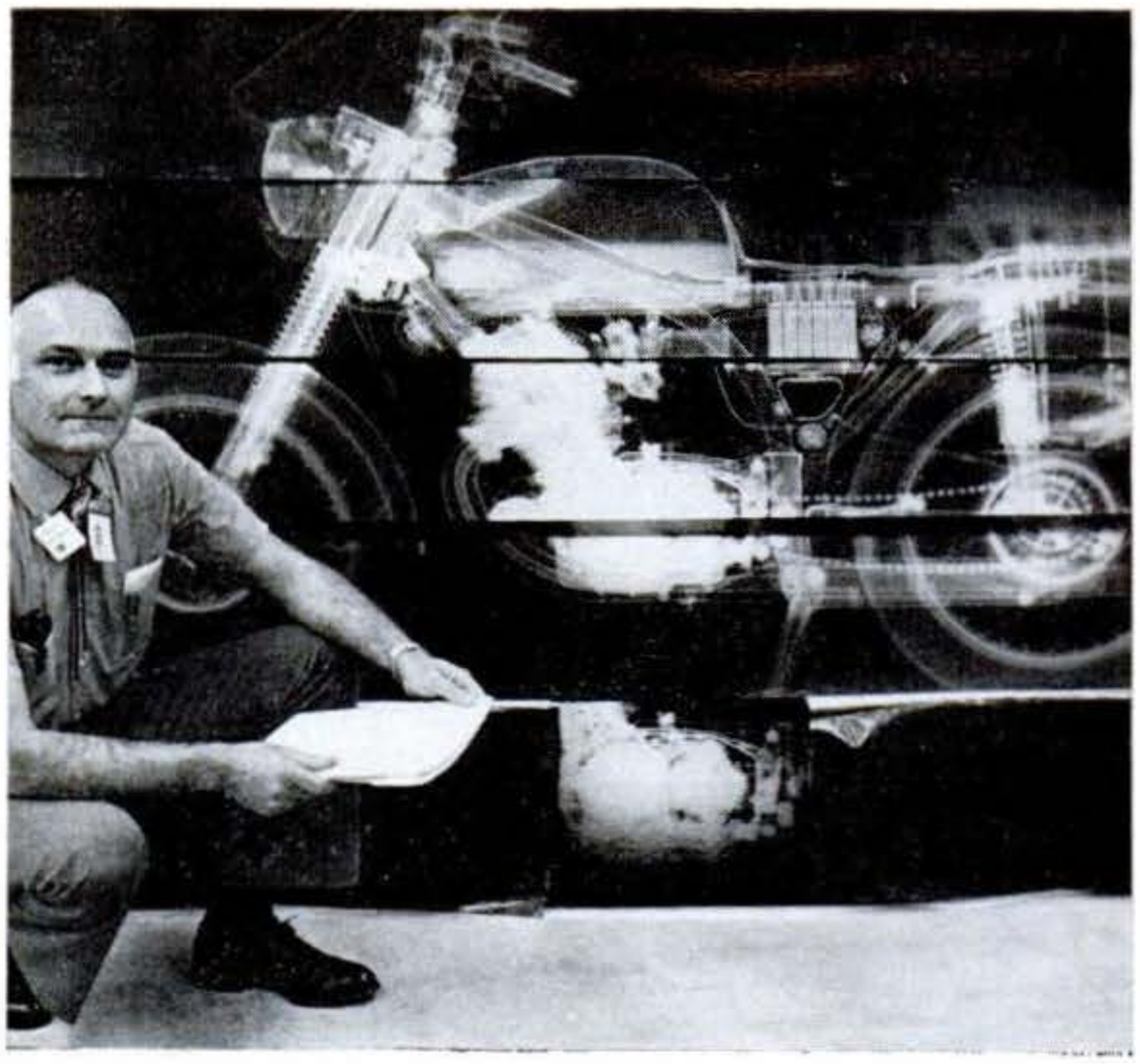
A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

Space game: ring around the antenna

Technicians seem to be playing ring-around-the-rosie as they wrap up a 30-foot furlable space antenna at Lockheed Missiles and Space Co. in Sunnyvale, Calif. With each man holding two ribs, the fine-mesh antenna is walked around, a step at a time, until it's coiled tightly around the hub. LMSC is readying the antenna for use on the NASA Applications Technology Satellite, a communications satellite being constructed by Fairchild Industries of Germantown, Md.

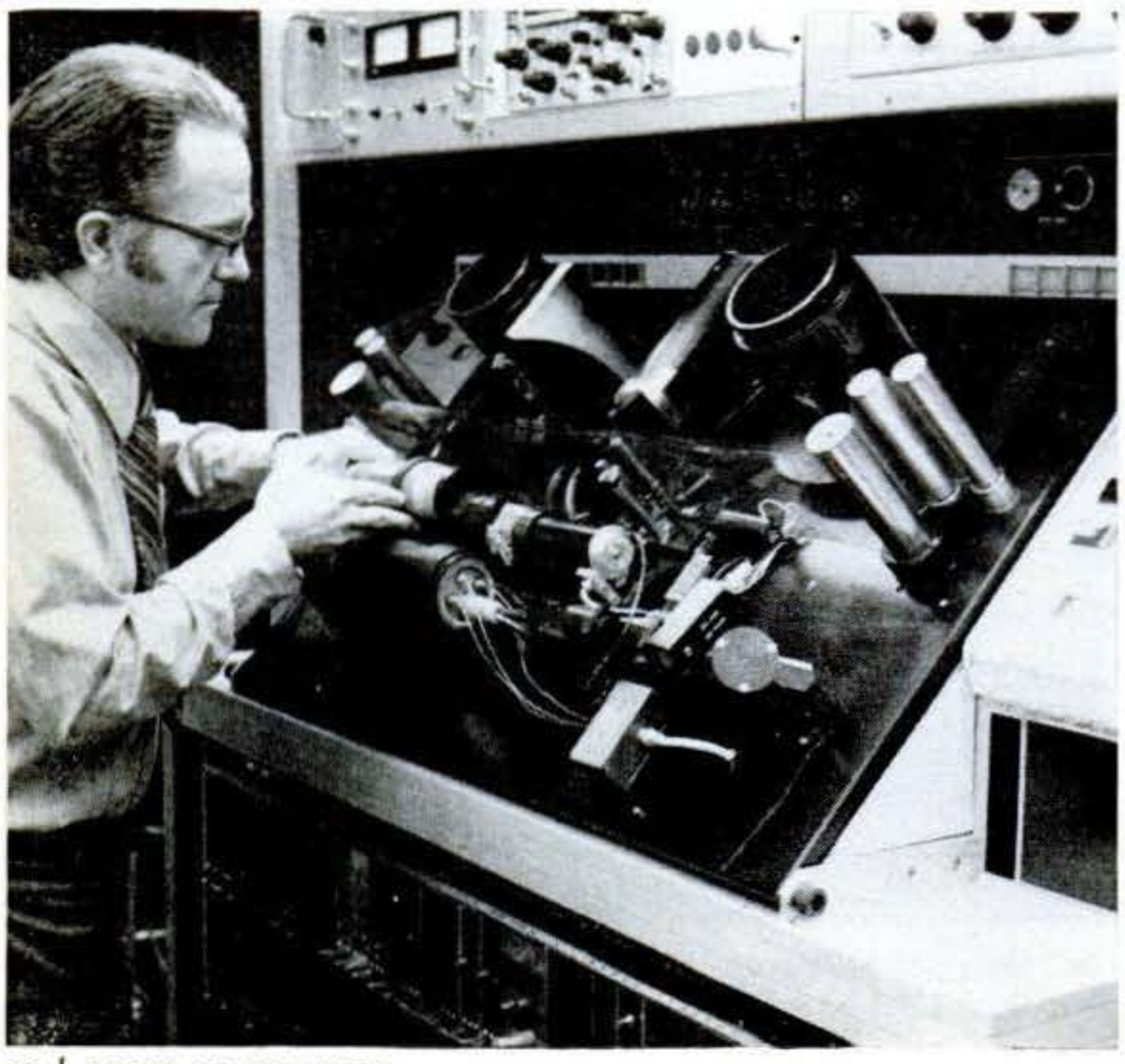
Mini-radar

A miniature radar set in a six-pound case helps guide this sailor through fog. He hears a whistling sound in the earphones—pitch depends on distance to objects. Range: two miles. Price: $640. Whistler Radar, Kimball Products, Box 343, Sudbury, Mass. 01776.



Giant X rays

This huge X-ray—revealing the cycle's half-full gas tank—was made with a 10-million-electron-volt X-ray machine. Sandia Laboratories uses a special forklift to tilt and rotate the X-ray machine, checking the structure of complete assemblies such as missiles.



Laser scanner

Got a high-quality picture you want to transmit electronically? RCA's new LR70 system can transmit and receive razor-sharp images from photos or sensors such as TV cameras. A 4.5-micrometer laser-beam spot both "reads" and "writes." A 25,000-line picture can be sent in less than four seconds.

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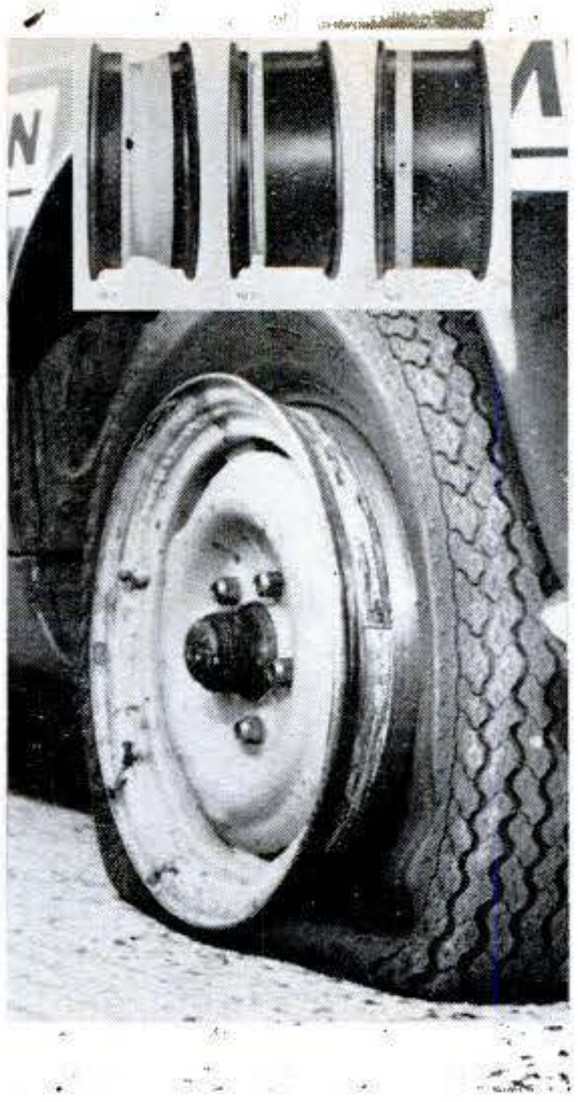
Bike-repair stand

Time for maintenance or bike repair? This sturdy repair stand lets you sit and relax while you work. An adjustable clamp allows positioning the bike to suit the job. Price: $24.95, plus shipping (12 lbs.). Kurey Products, N89 W17089 Highland Ct., Menomonee Falls, Wis. 53051.



Safety wheel

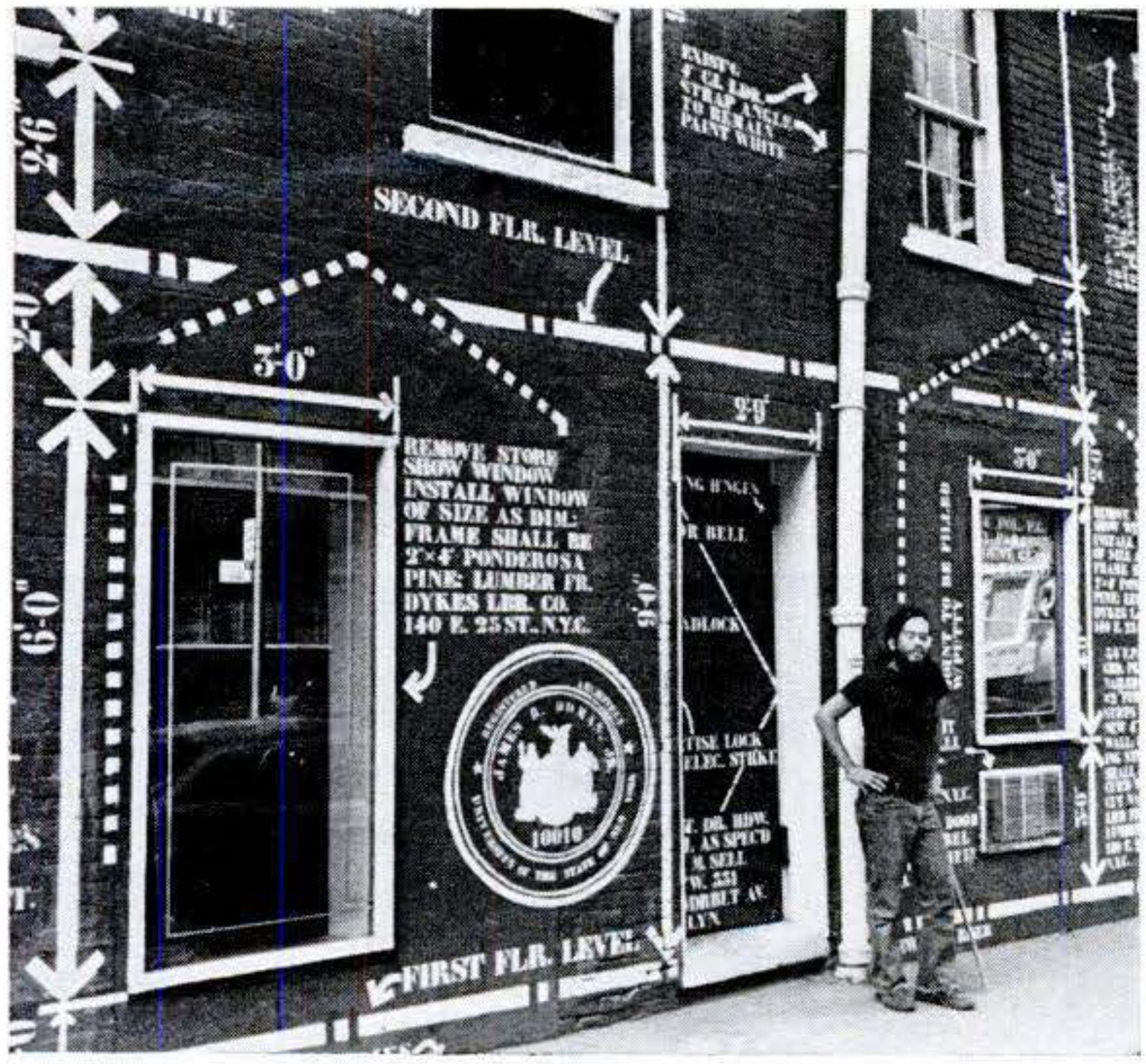
Tire blowouts are less hazardous with this new rim. Unlike conventional deep-well wheels (left in inset), this one has a cylindrical rim. A narrow channel (center) aids fitting tire beads; then a metal band is locked to cover the rim groove (right). Avon, a British firm, makes it.

Coin vacuum

In 20 seconds, this vacuum hose sucks out $200 in coins from a bus coin box. Hands never touch the coins; they're cleaned and sorted within the machine, then fed to a high-speed counting device. The system is used by the New York City Transit Authority.

Tire turf

Here's what you can do with old tires: Turn them into artificial turf. Goodyear does it. They mixed shredded tires and pigmented latex, and came up with this ground covering, now being tested. In earlier versions, they raked the stuff onto the ground, and then rolled it flat.



1-to-1 blueprint

Can't understand building blueprints? To help customers understand theirs, New York's James D. Roman Associates, an architectural firm, painted renovation plans on their two-story office building. The giant one-to-one blueprint even notes addresses of contractors.

Cooking post

Topped off with a light globe, this all-in-one cooking column may do away with kitchens. The cooking post, a design at a London exhibit, would be installed in any room. Drop-in sections could range from a microwave oven to an automatic dishwasher.

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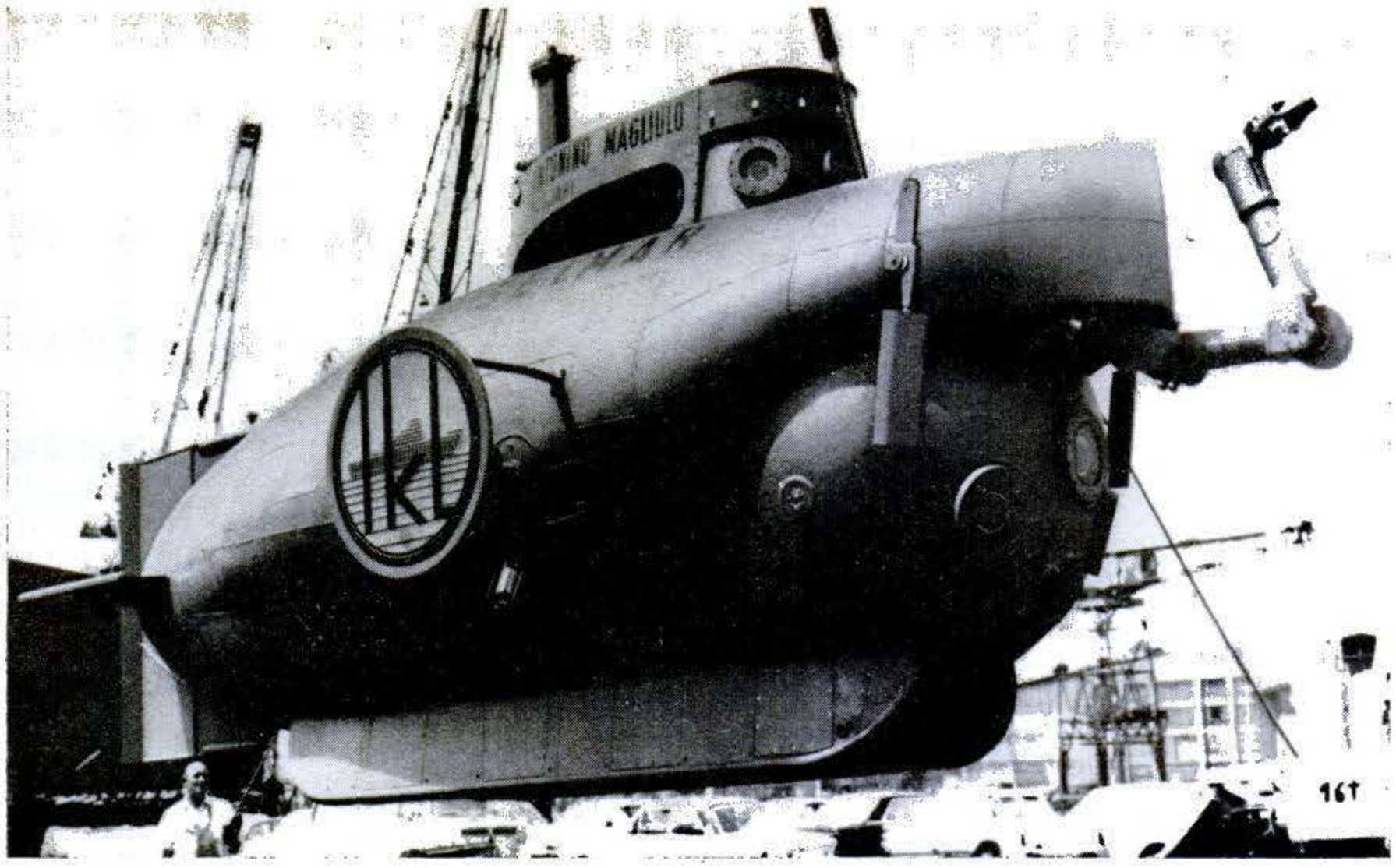
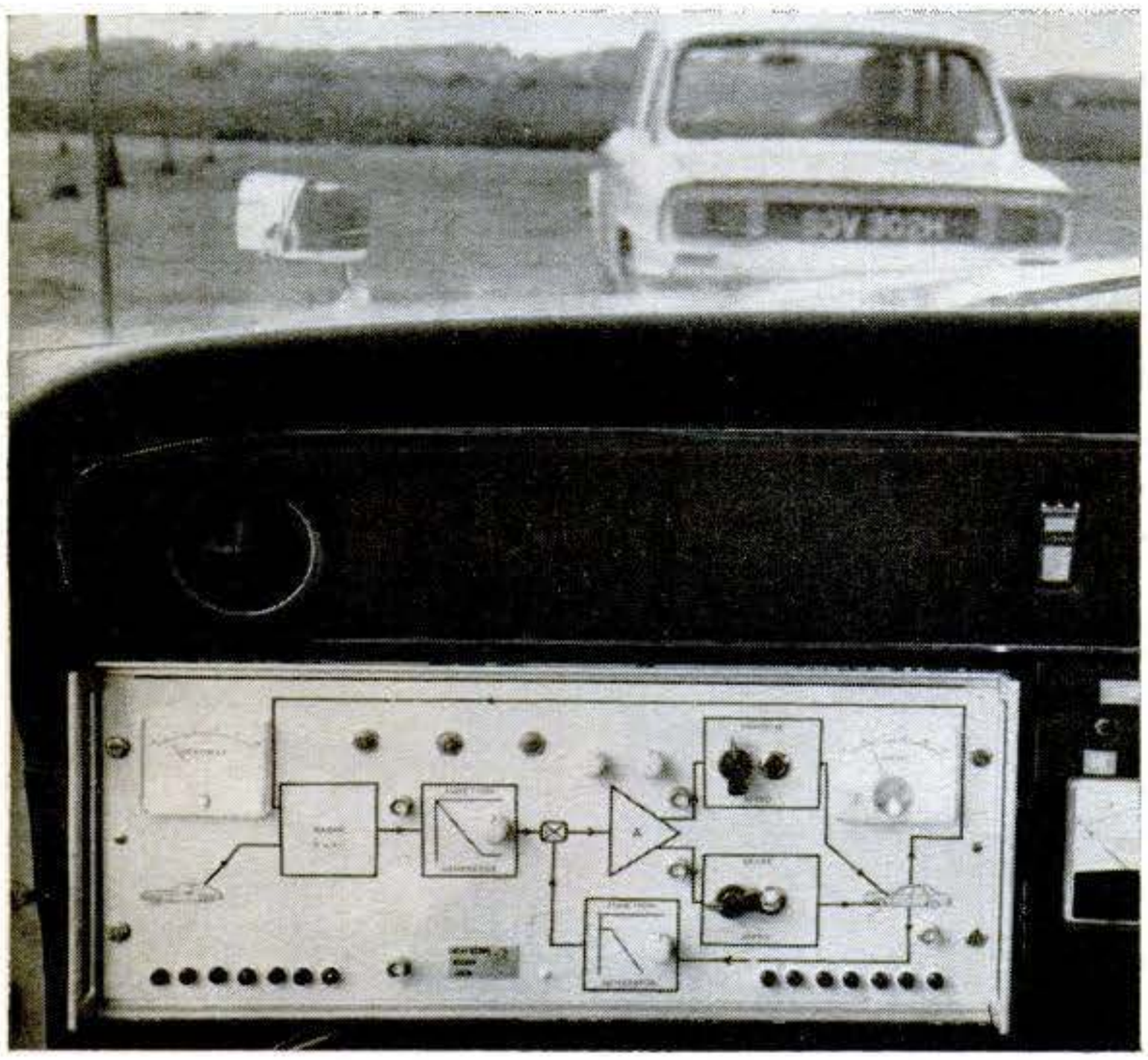
What's New



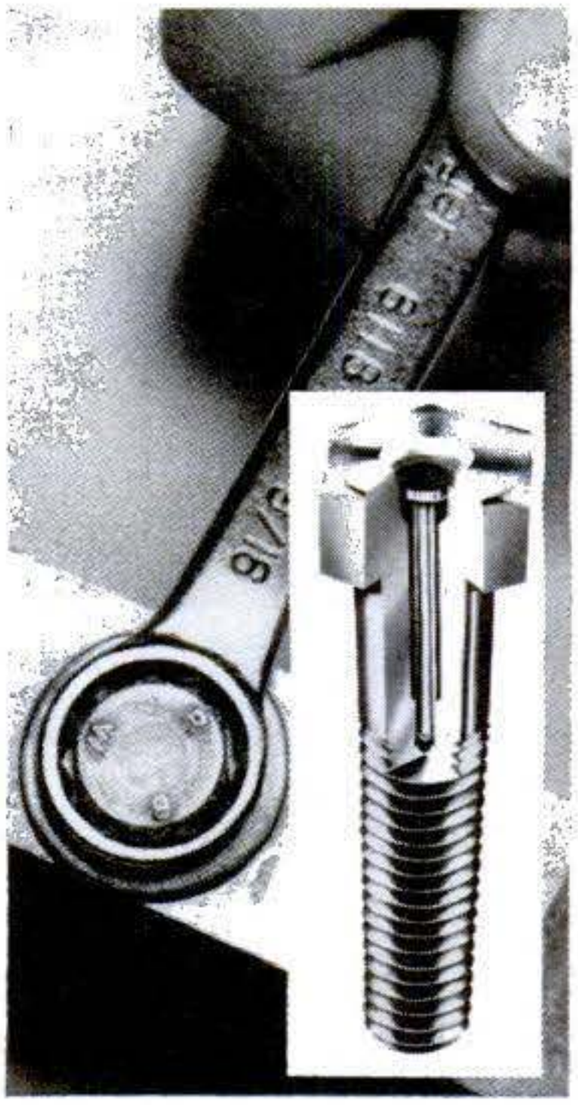
Coral picker

What's the best way to gather coral? Climb aboard this new submersible designed for the job. A long-reach hydraulic gripping arm does the work. The German-built Selmar operates at 1000 feet with a three-man crew for up to 48 hours. Maximum speed is three mph. Range: 21 nautical miles.



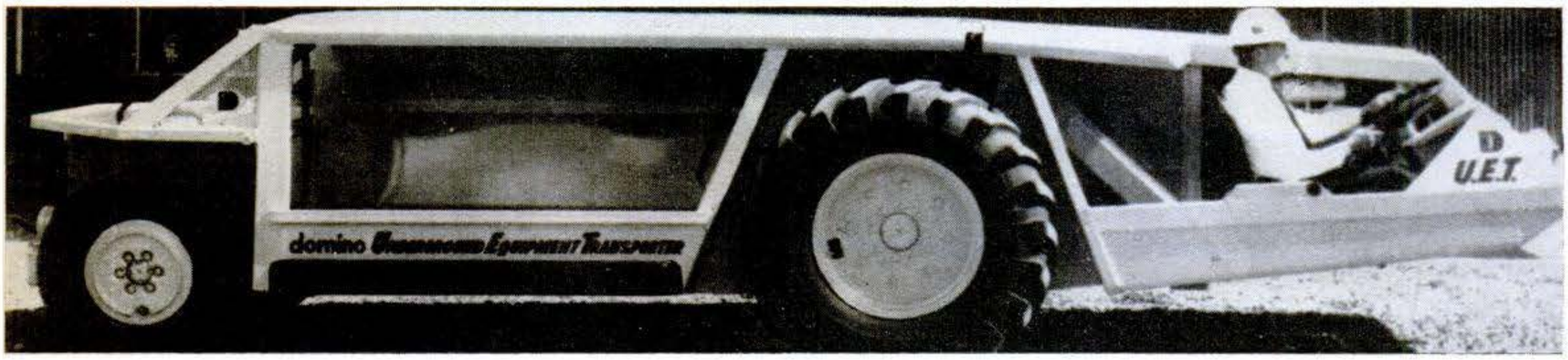
Anti-collision radar

This experimental radar system adjusts brakes and throttle to prevent rear-end collisions in fog or if you nod off. You override the system by touching a pedal. Horn antennas are concealed behind the grille. Developed in Britain by Joseph Lucas, Ltd., the system's range is 120 feet.



Torque-display bolt

Tighten bolts till they're black and blue? Right. These Tell-Torq bolts change color as you tighten them—from red-orange through blue-black. A windowed chamber fills with light-absorbing fluid, obscuring the reddish gauge pin. Gyrafalcon Inc., 1104 Fernwood Ave., Camp Hill, Pa. 17011.



Mole on wheels

Nosing through mines and tunnels, this mole-like carrier can transport 12 workers, with a payload capacity of four tons. The body is seven feet wide, 4½ high. Power is from a 45-hp diesel. Domino Equipment, Gateshead, N.S.W., Australia, makes it.

Golf-ball heater

Boost driving distances up to 20 percent? That's the claim for Fireball. It heats and keeps three golf balls warm for six hours. You plug it into a wall outlet before the game. $14.95. Fireball, Box 2355, Palos Verdes, Calif. 90274.

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What's New IN PHOTOGRAPHY

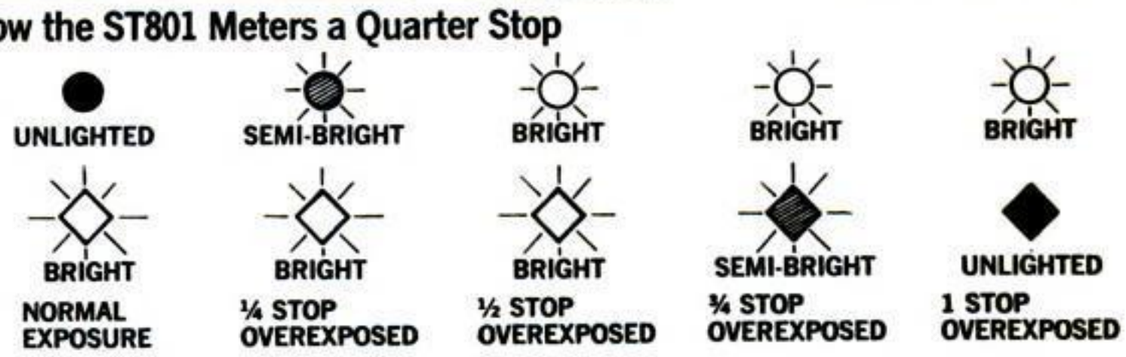
Energy saver

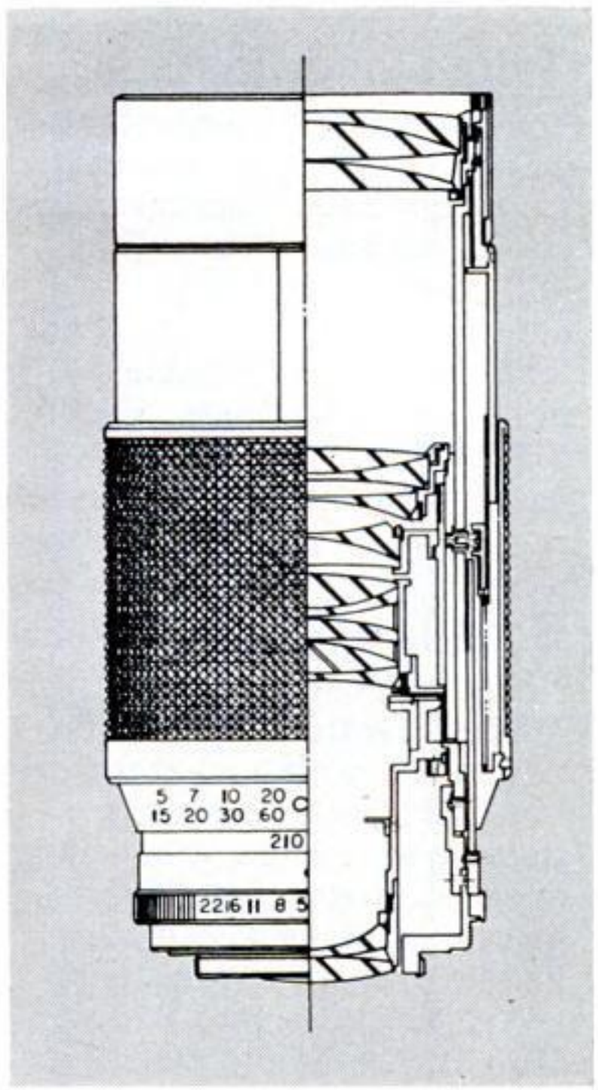
This Braun 2000 Vario Computer electronic flash puts exactly the right amount of light on a scene, while conserving unneeded energy (instead of "dumping" it). Result? You get more flashes per charge and faster recycling. Prices, depending on light output: $119.95 and $139.95.

Instead of a needle—flashing lights

Low light levels are the meat of the advanced Fujica ST801 single-lens-reflex camera. There are no needles to squint for; instead, seven light-emitting diodes, flicking on in varying sequences, permit you to control exposure within a quarter stop. The diagram at right shows the sequence between normal exposure and one stop overexposure. This sequence also takes place between other adjoining diodes. The system offers not only bull's-eye exposure, but the possibility of precise over- or under-exposure for special effects. The meter uses a silicon cell instead of a CdS cell, for faster reaction. Other camera features: full-aperture light measurement, so you always see the scene with the lens wide open; shutter speeds to 1/2000 sec.; multicoated lenses, to reduce flare; a silvered (rather than aluminized) prism, for a bright viewfinder image; depth-of-field preview button. With f/1.8 lens: $329.95.

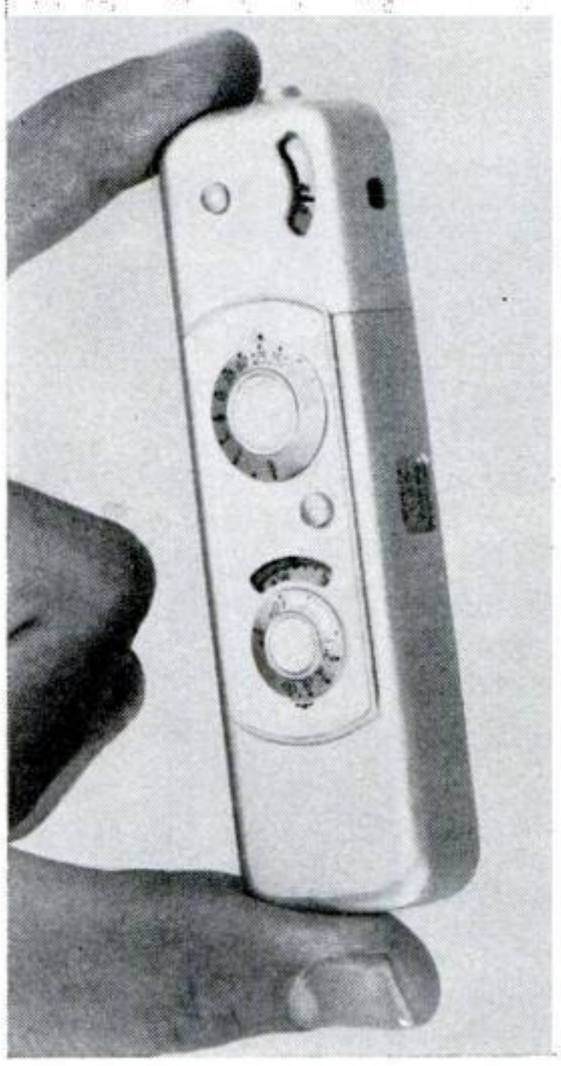
How the ST801 Meters a Quarter Stop





70-210mm lens with one zoom/focus control

An extraordinary close-focusing ability—three inches from the lens—gives Vivitar's new 70-210mm f/3.5 zoom lens a true macro capability: an image/object ratio of 1:2.2. And an unusual design permits zooming and focusing with one control; the same elements that move as the lens is zoomed are also used for focusing. The 15-element lens weighs 29 ounces, is 6⅛ inches long, and comes in automatic mounts for Pentax, Nikon, Canon, Minolta, and Konica SLRs. Vivitar says it'll compare favorably in performance with the "finest original-equipment telephoto lenses." Price: not yet announced.



Lighter lightweight

Would you believe they've knocked a half-ounce off the old Minox B? The new Minox BL weighs in at a featherlight 2¾ ounces, yet includes CdS electric eye, flash synch (for bulb, cube, or electronic flash), and a host of automatic features. It's $200 with chrome finish.

Slave tripper

Any electronic flash becomes a slave with Honeywell's new Foto-Eye II. A standard shutter cord connects it to a flash unit. Mounting devices include an accessory-shoe receptacle, tripod-screw mount, and even (shown) a rubber band. It's claimed to be sensitive to 200 feet. Price: $14.95.

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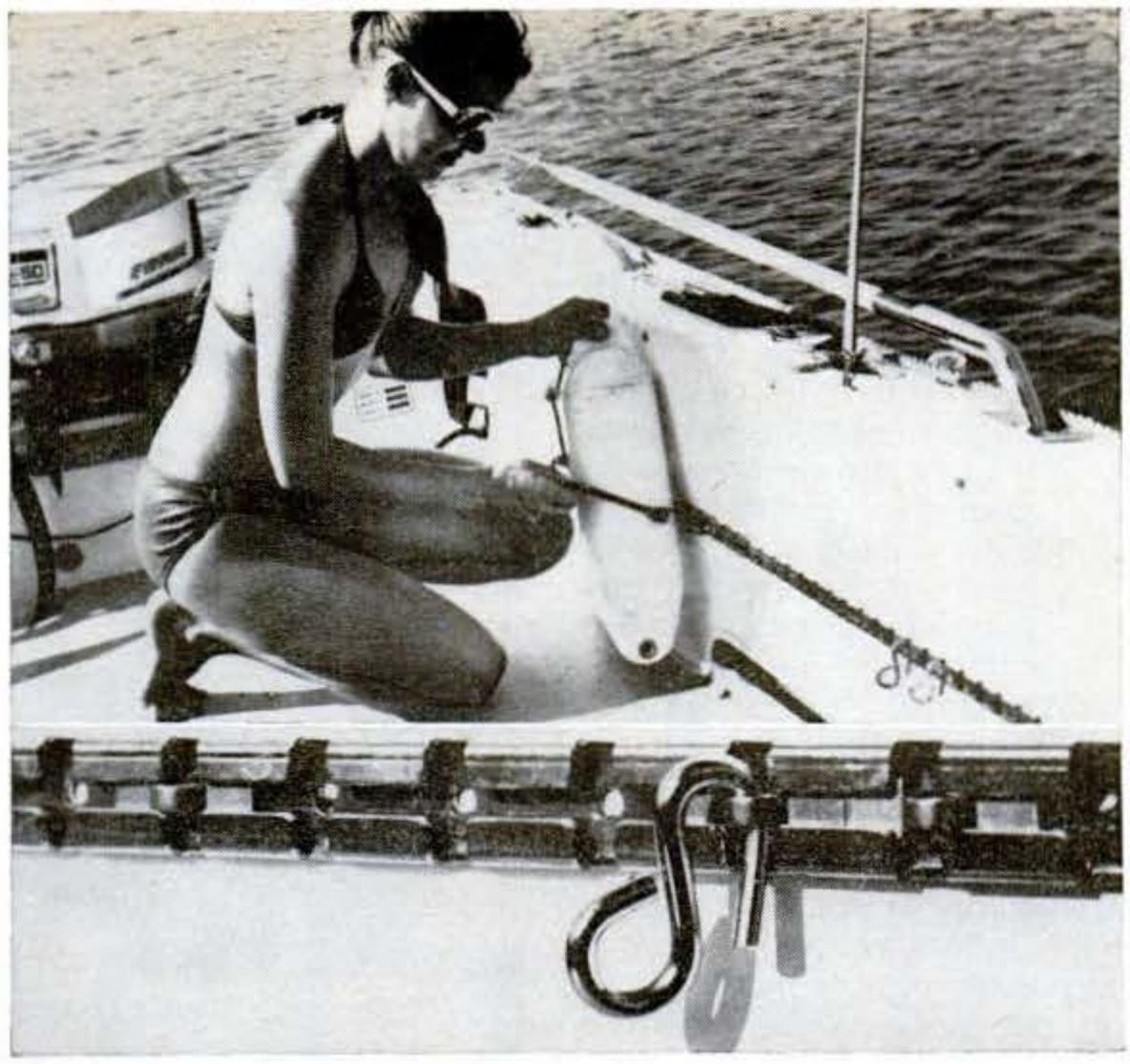
What's New IN BOATING

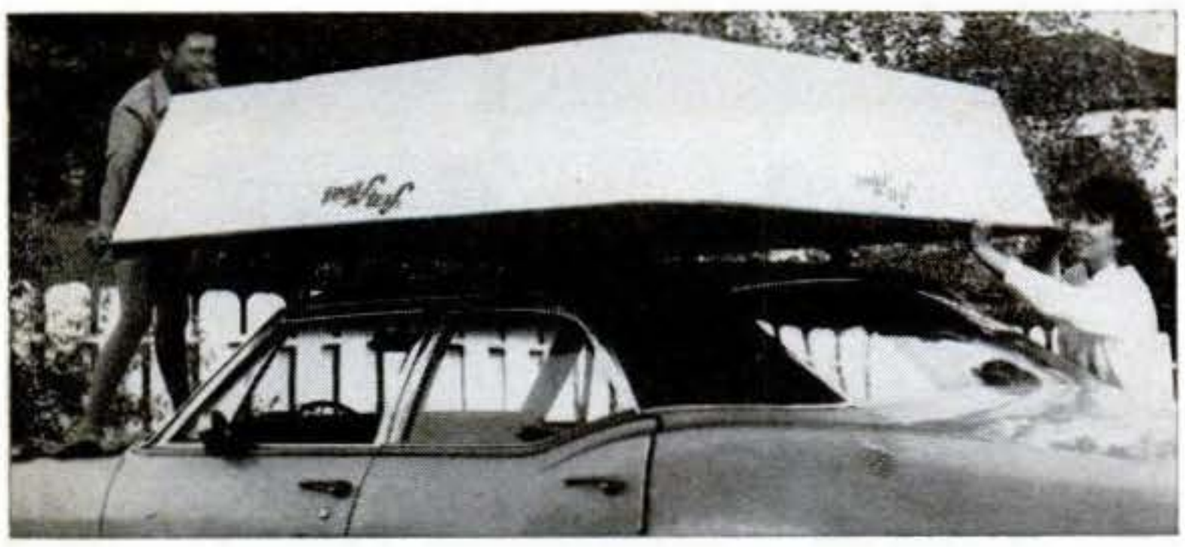


Stowage strip

If stowing loose gear's a problem on your boat, a strip of Chanltrak may help. Just screw on a length, position the sliding travelers, and lock them with hooks or shock cord. It's available in one-inch and ¾-inch track widths. A. L. Hansen Mfg. Co., 2155 Delaney Rd., Gurnee, Ill. 60031.

Lightweight boat

This aluminum 12-footer weighs in at only 93 pounds and handles up to three adult anglers. A cartopper, Easy Rider has a 55½-inch beam, 16½-inch depth. Rated horsepower limit is 20. From Michi-Craft Corp., 19995 19 mile Rd., Big Rapids, Mich. 49307.



Take-along float

You don't have to live on the water to lounge on and dive from Fun Float. This seven-by-seven-foot foam float weighs 160 pounds, and has twin carrying grips for toting. Other features are a detachable ladder and vinyl bumpers. Price? $299. Multi-Pro Inc., 4711 N. 32nd St., Milwaukee 53209.

Boat lift

No more cables, gears, or pulleys. Hydro-Hoist lets you "dry-dock" your boat at the touch of a button. Boats are raised and lowered by injecting or exhausting air from fiberglass float tanks. Five models handle boats up to four tons. Hydro-Hoist Co., Inc., 820 W. 10th St., Claremore, Okla.

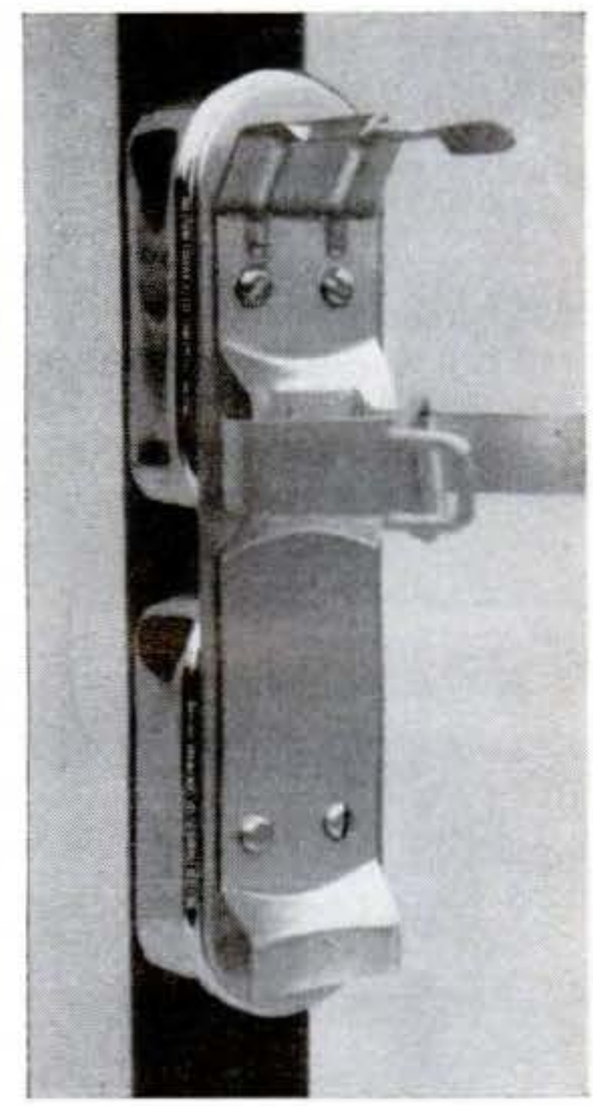
Sporty runabout

If you're a hotdog water skier, Sutphen's Sport Pacer 173 is for you. This 17-footer can reach 60 mph with a 120-horse outboard, says the maker. Comes with carpeted cockpit, mechanical steering, and compartments for ski equipment. Sutphen Marine Corp., Lake Hopatcong, N.J. 07849.

What's New FOR YOUR CAR

Pull power ➤

Lift a ton with your chain saw? Sure, with the MiniWinch. The little 12-pound unit can be powered by any standard chain saw, has a 100:1 gear reduction system to unstick your car or do other winching jobs. It's made by Triway Winch Div., 7819 Old H'way 99, Marysville, Wash. 98270.



Extinguisher mount

If you can't think where to hang a fire extinguisher in your Jeep, Bronco, Blazer, or other 4WD vehicle, here's an answer: a bracket that mounts on the rollbar. It comes in models to fit 1¾" and 2" rollbars, retails for $6.95. Nelson Products, Box 23022, San Diego, Calif. 92123.

Oil check ➤

Check your oil from the driver's seat? You can, with the Push-button Oil Checker. A green light says it's okay. Or you can use it to check transmission fluid. The unit is $19.95. A dual unit, for oil and transmission, is $29.95. Winfield Enterprises, 2532 W. Wethersfield Rd., Phoenix, Ariz. 85029.

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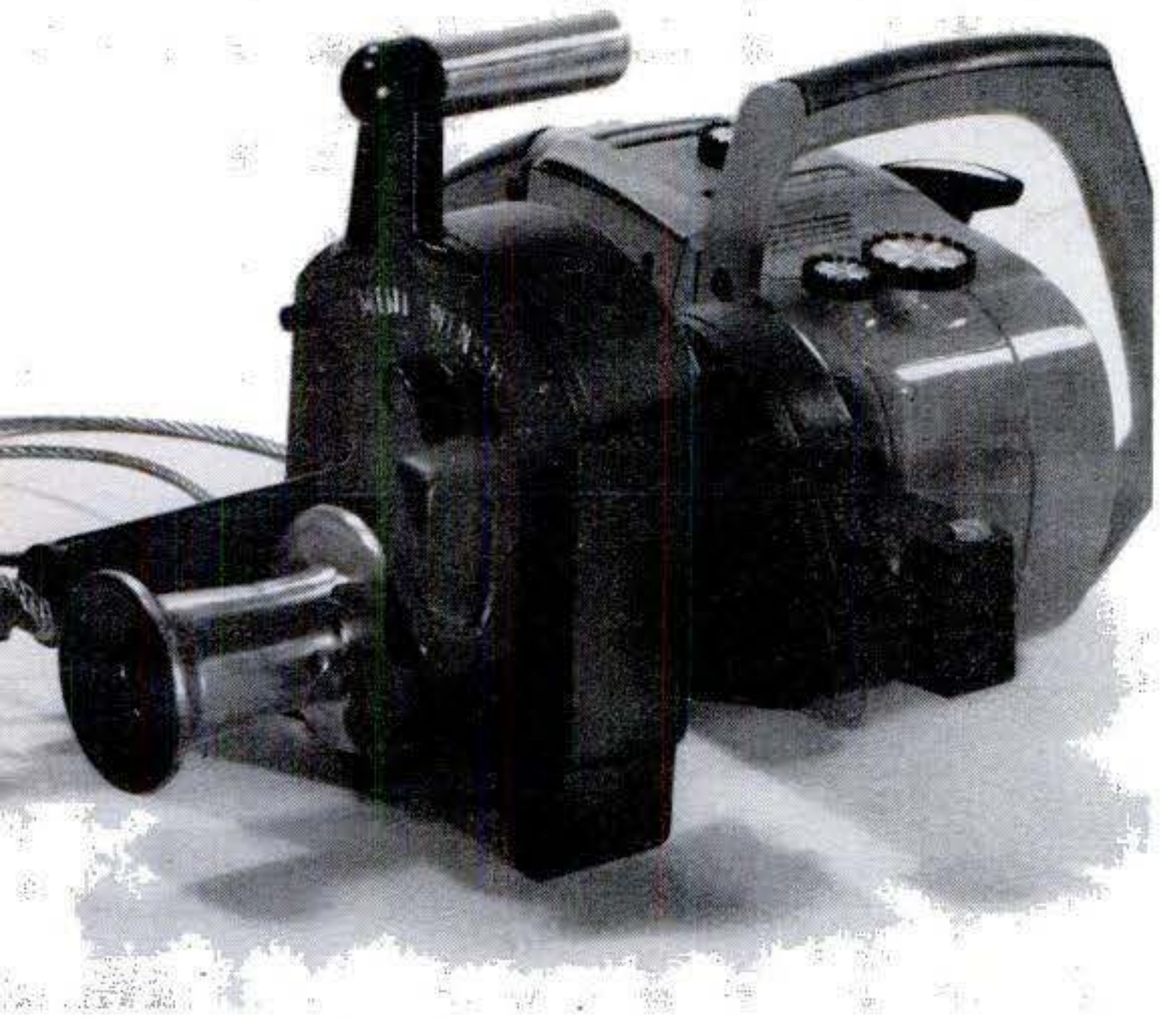
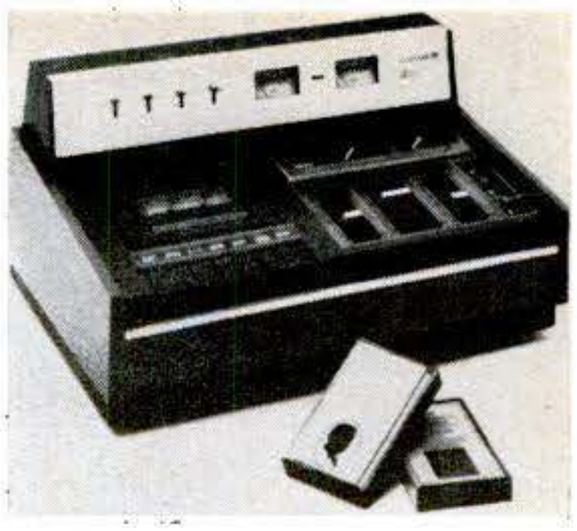
What's New IN ELECTRONICS





Hi-fi sound panels

These new thin speakers hang on your walls like paintings, or stand up with special feet provided. Fisher's decorative sound panels—only 2⅞ inches deep—come in numerous fabric designs. Frequency range: 40 Hz-18 kHz. They'll handle 25 watts RMS. Price: $138 each.

Cassette deck

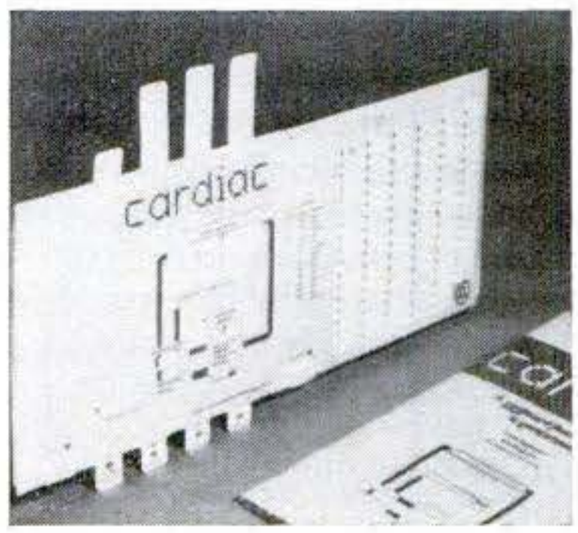
Console styling makes the new Wollensak 4780 record/play deck a standout addition to your hi-fi system. There's Dolby noise-reduction circuitry, provision for chromium dioxide tape, and memory rewind—you preselect a rewind stop point. Frequency response: 30 Hz-15 kHz. $260.

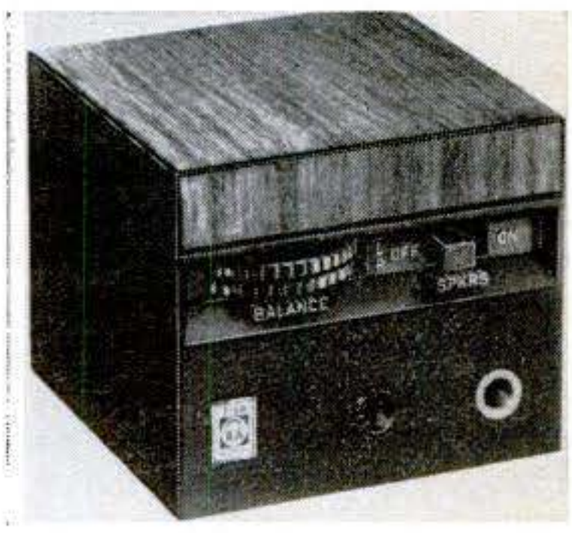
Sunroof kit

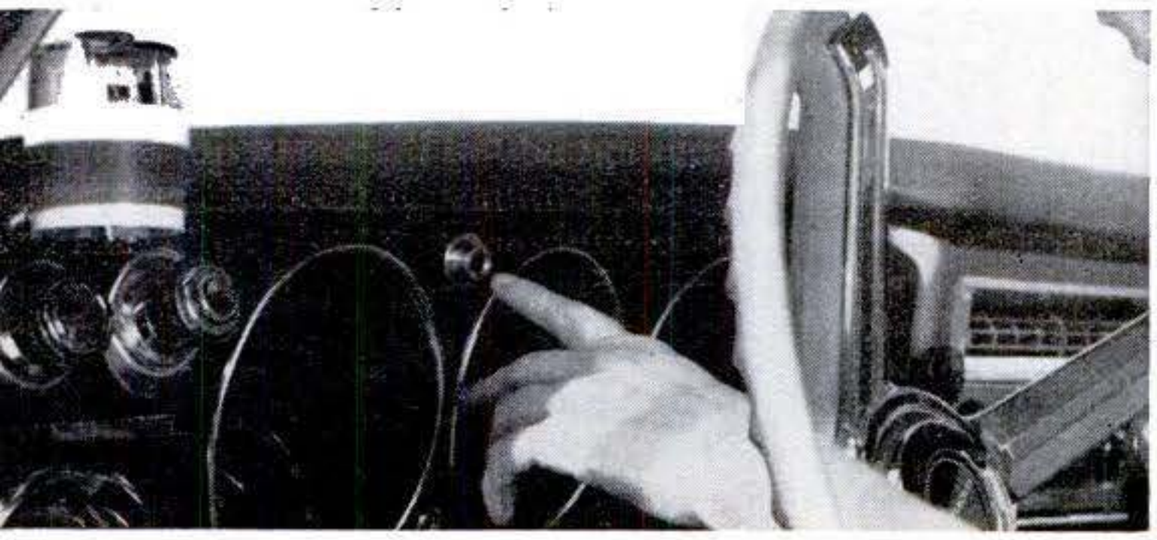
t takes only two hours to in-tall your own sunroof with this it, says the maker (U.S. Sun-oof Corp., Box 174, Bensen-ille, Ill. 60106). Complete kit, ncluding an 18"-by-35" moked acrylic panel and a emplate for cutting the roof pening, is $89.95.

Snow biter

Mount Sno-Treds on your regular tires, says the maker, and you get a "scoop" action that puts the bite on snow. Installation time: two minutes per tire. They're made by Detwiler Corp., 36 New York Ave., Westbury, N.Y. 11590. You can get them at Montgomery Ward.







Computer training kit

Here's a low-cost self-study kit developed by Bell Labs for learning fundamentals of computers and computer programing. Included is a 53-page booklet and non-electronic computer-simulation device. $2.95 from Comspace Corp., 350 Great Neck Rd., Farmingdale, N.Y.

Headphone center

Like to adjust stereo volume from your favorite chair? The T-5A remote-control station from Koss takes two headphones—lets you switch to headphones or speakers and headphones. There's a volume/balance control for one set of phones. It's $9.95.

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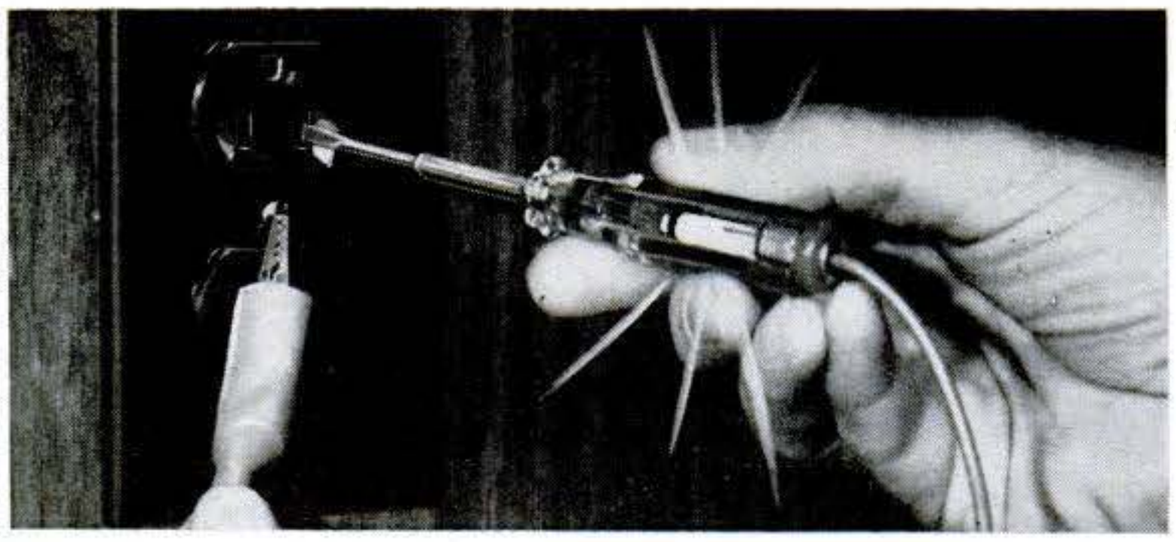
What's New IN TOOLS



Circuit checker

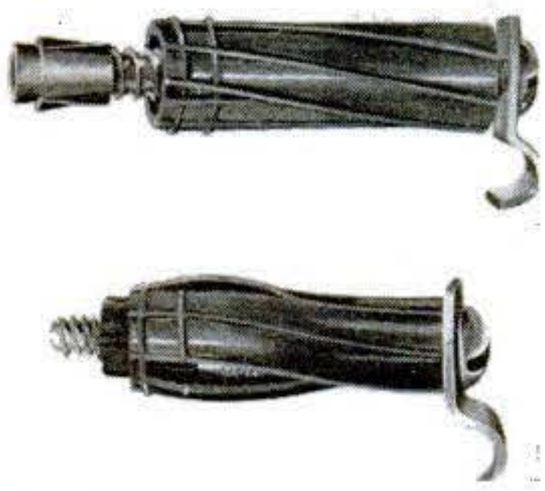
Vaco Products has improved its popular 100-500-volt circuit tester. Now it comes in a grounded version. Clip the grounding wire to the box or ground wire and touch the probe to the wire or outlet being checked. A light in the handle flashes on if all's okay. Price? $2.25.

Wood-carver's kit

Want to try your hand at wood sculpture? Stanley's got the kit to get you started. For $13 you get round and flat Surform files, pocket plane, coping saw, outlined piece of wood, and a 24-page instruction book explaining the secrets of Surform sculpture.

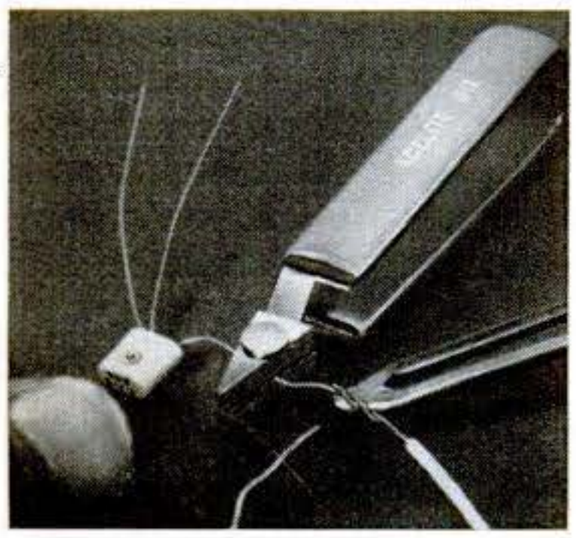
Dual tool

Sand or polish—Shopmate's new two-speed model 2480 lets you do either. Use it at 2000 rpm for polishing and waxing. Switch to 2500 rpm for high-speed disk sanding. It's double insulated and features modular construction for easy repairs.



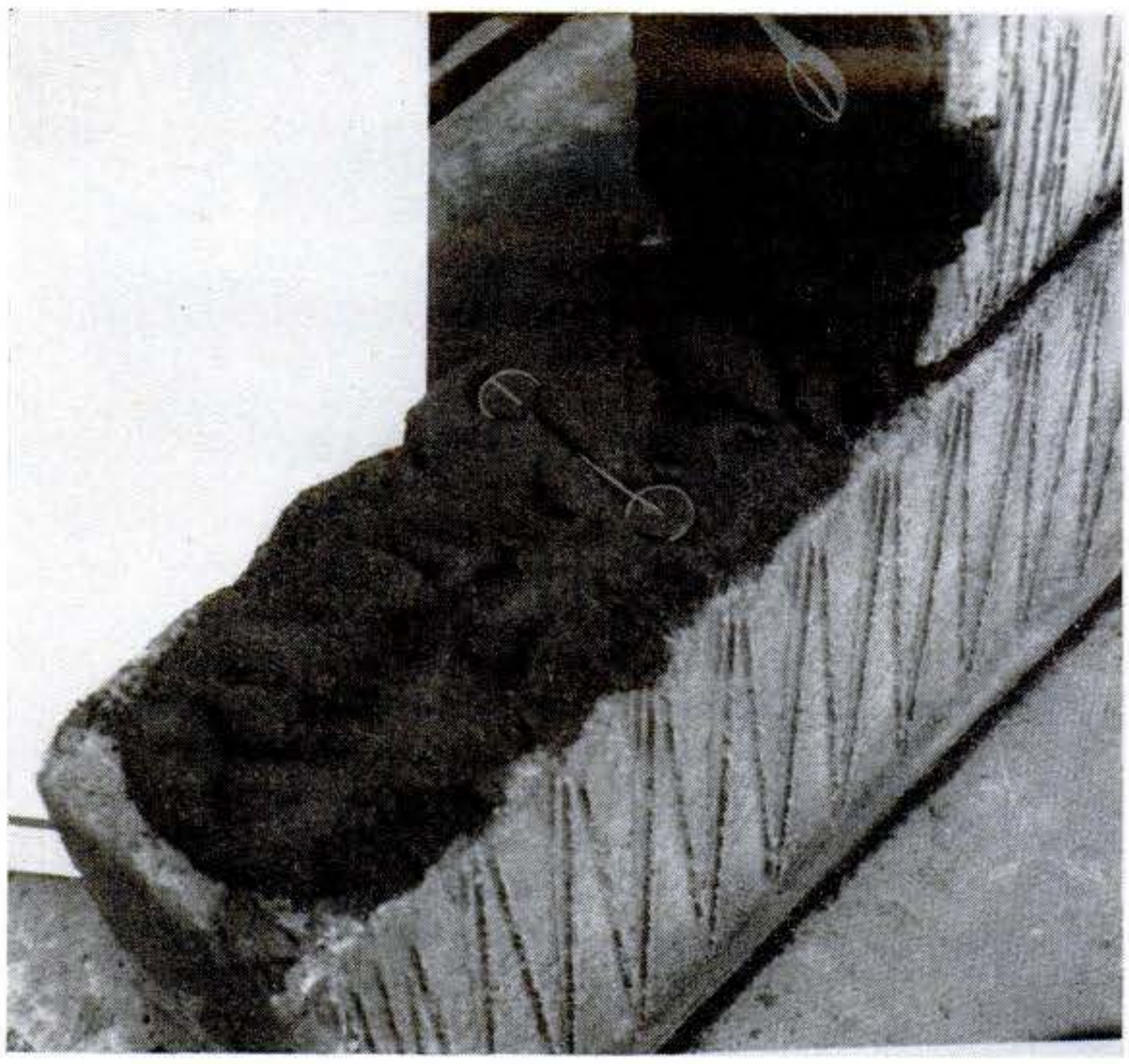
Up-tight anchor

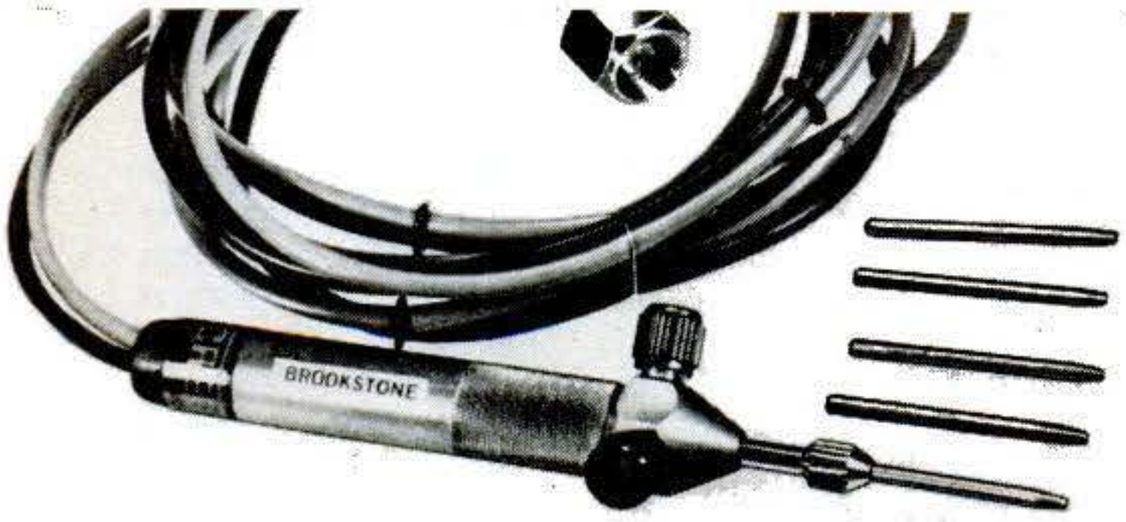
Steel, nylon, and polycarbonate combine to make a wall/floor anchor capable of supporting over 100 pounds. Tap it into a hole, tighten the screw, and it expands to grip the sides. Sleev-Lok anchors are by Precision Plastics, 1500 E. Bay Dr., Largo, Fla. 33540.



Transistor saver

You'll get double duty from Xcelite's new heat sink. While its copper jaws soak up excess heat they also hold the parts being soldered. Nickel plating on the jaws prevents adhesion of stray solder; insulated cushion grips make for burn-free handling. $2.40.





Hot item

Lots of heat, right where you want it. That's what this mini-torch gives you. It runs on a choice of fuels, comes with your choice of tips. It's $50 plus postage from Brookstone, 12 Brookstone Bldg., Peterborough, N.H. 03458.

Level best

Have trouble laying bricks dead level? These English masonry spacers may solve your problem. Trowel on the mortar and drop in a pair of spacers—they automatically set the height for the next course. Acculay spacers are by P.E. Products, Wolverhampton, England.

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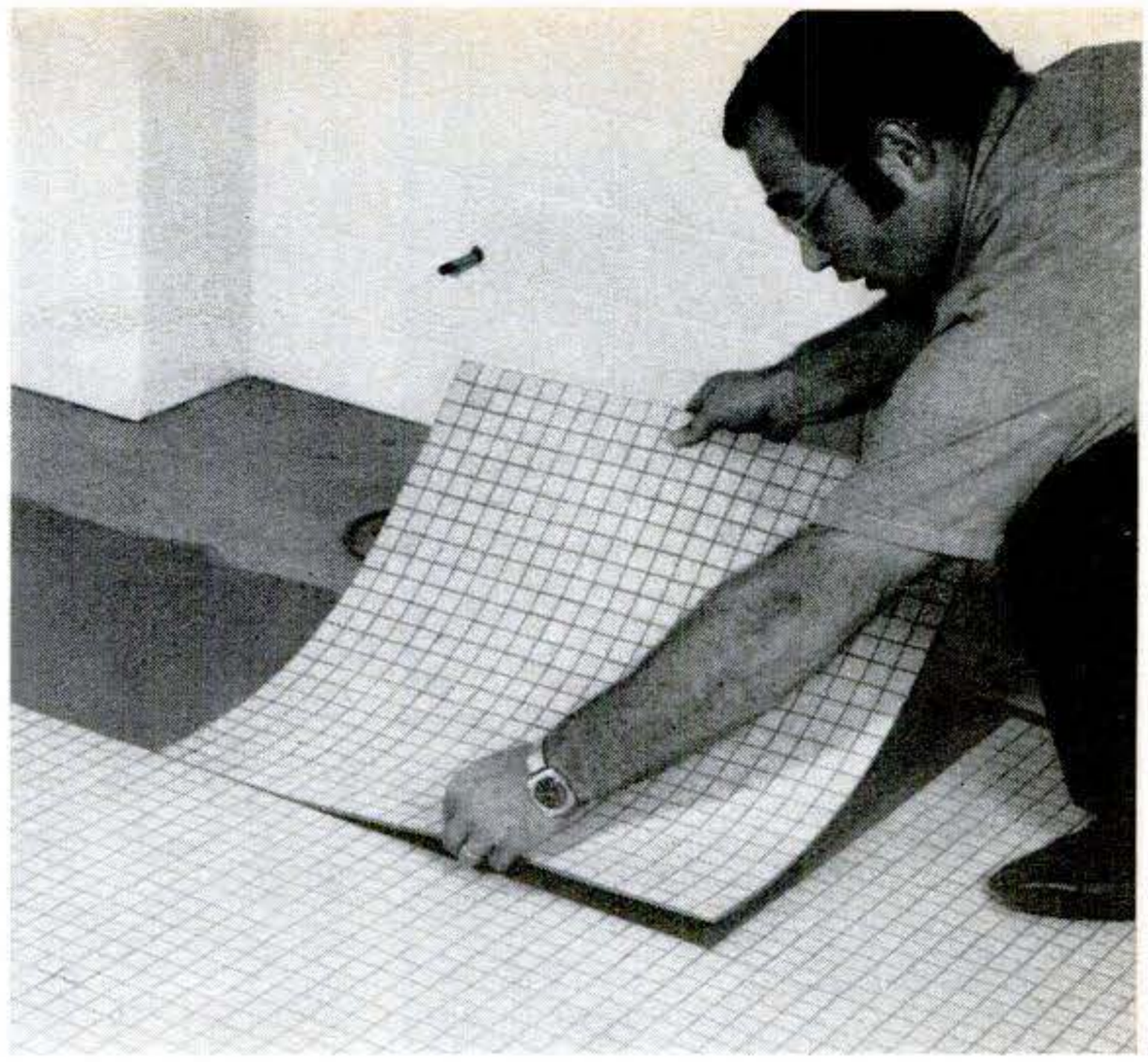
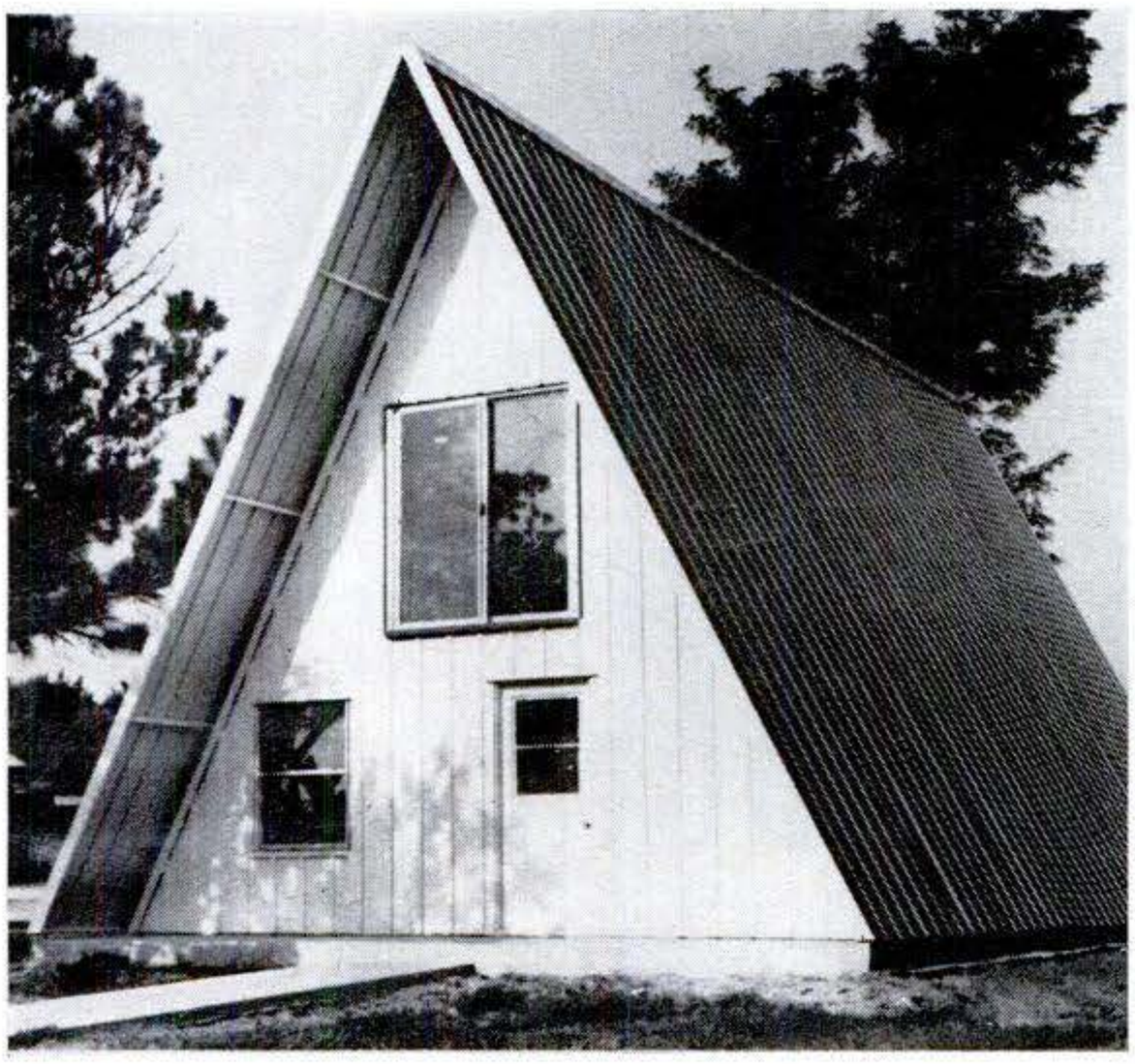
What's New IN HOME IMPROVEMENT

No-grout tile

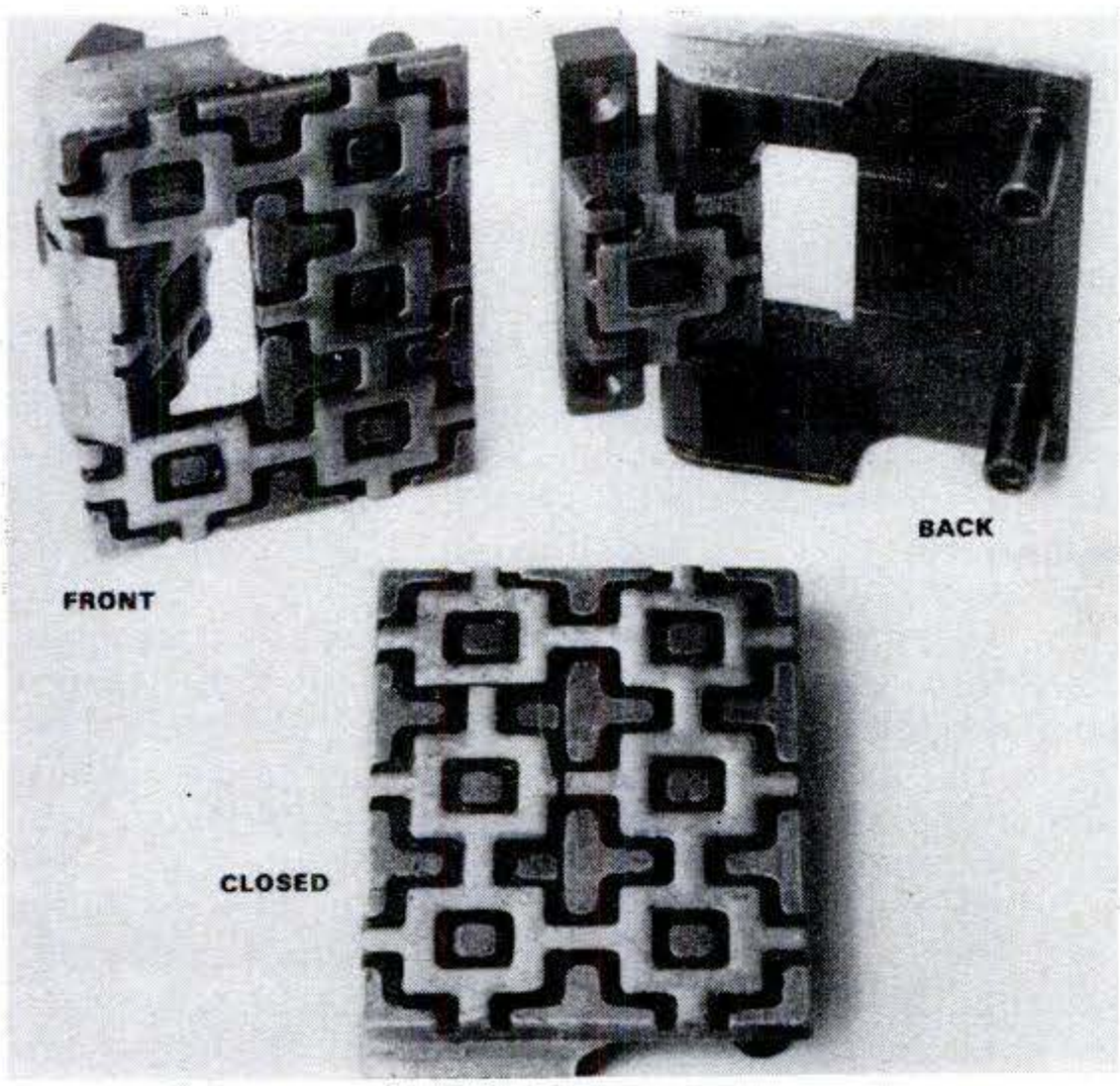
Grout is out with the new Redi-Set tile system from American Olean. The two-foot-square mosaic-tile sheets come pre-grouted with flexible polyurethane—you stick them in place, and caulk only around room edges, plumbing pipes and fixtures.





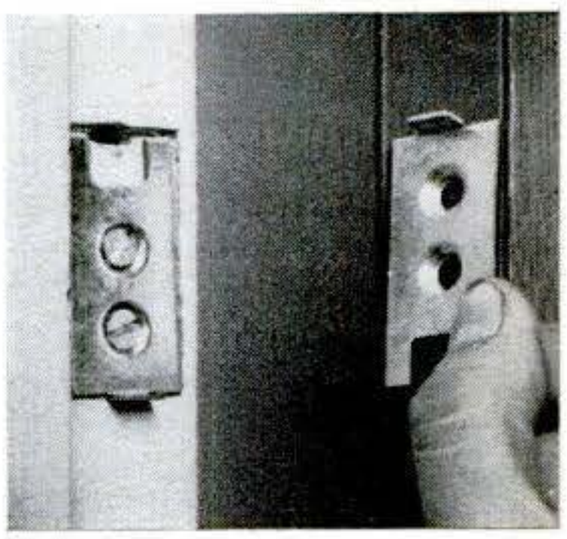
Instant A-frame—a short-order house

In a hurry for a vacation home? This prestructured A-frame goes up in a day. The secret of the speed lies in its 16 factory-built sections with steel frames, fiberglass insulation, steel outer surfaces, and wood-paneled interior surfaces. The two-story home has kitchen, bath, living room, and three bedrooms all packed into 1350 square feet of living space. Allied Steel Products, Box 50187, Tulsa, Okla. 74150, makes it. Price is around $15,000, erected.



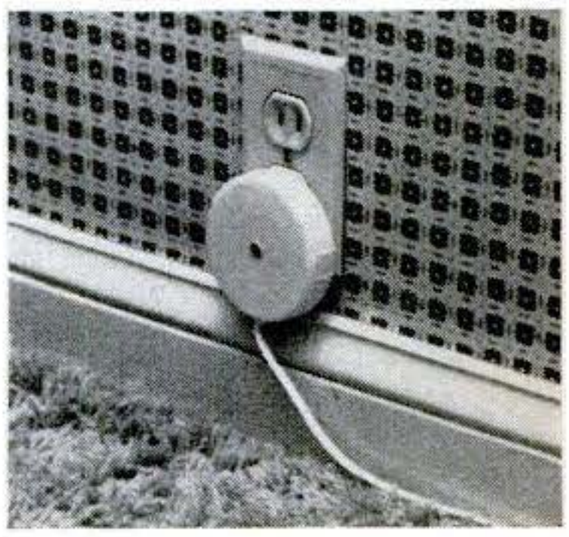
Burglar baffler

One way a burglar gets through a locked door is to remove hinge pins. Saf-T-Door puts an end to that by securing the door's hinge side. It's $1.25 from Cal American Hardware, 17921 Sky Park Blvd., Suite E, Irvine, Calif. 92707.



Self-coiling cord

What's always ready, but never in the way? A new retractable extension cord from Thomas Sales and Marketing, Bloomington, Minn. The six-foot cord plugs into your wall outlet, adjusts for exact length, connects to other cords. It's $1.98 and UL approved.



Accent hinges

Hinge pins, barrels, and mounting screws are all out of sight—hidden when the door is closed—in a unique series of hinges called Sculptura V. Gries Reproducer Co., 400 Beechwood Ave., New Rochelle, N.Y. 10802, makes the hinges.

Drip stoppers

Sick of fooling with faucet washers? A new faucet with a carbide-disk valve is warranted for 1000 months (83⅓ years). Bradley Corp., Menomonee Falls, Wis. 53051, makes it. The company also sells a mixing-valve faucet with the same warranty.

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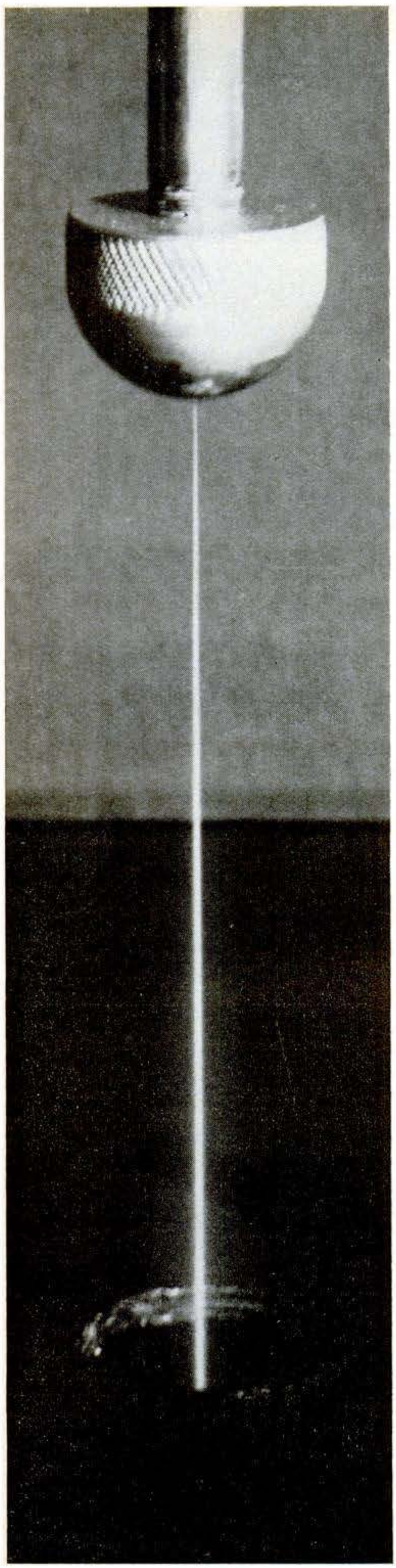
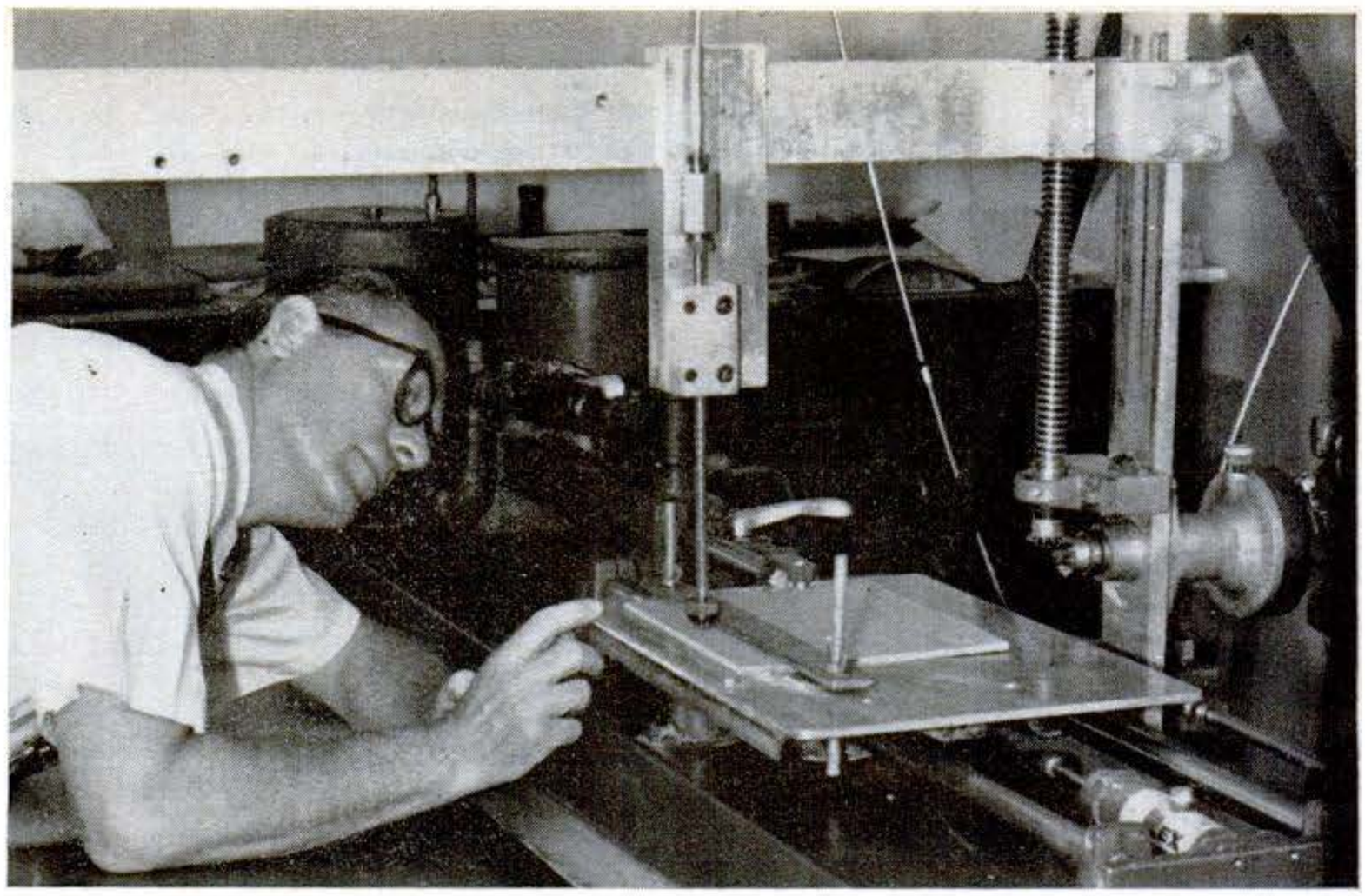


High-pressure water jet never dulls, needs no turning radius, cuts in any direction. Jet here has been stabilized by a special long-chain polymer. Untreated, it would flare out in a wide fan, ineffective for the job of high-speed cutting.



Shuttle table used by McCartney engineers to make cuts in test materials is studied by author. Pressure, nozzle size, feed rate—all are important variables. McCartney does not make cutting machines, just the critical components for tool manufacturers.

Newest Cutting Tool..

By E. F. LINDSLEY / *PS Midwest Editor*

Take ordinary tap water, mix in a tiny bit of additive, pressurize to 70,000 psi, and discharge it through a hole .008" to .010" in diameter. You'll get a needle-sharp jet that looks innocent but is one of the newest and most effective cutting tools for some very hard-to-cut materials.

To see *how* effective, I went to the McCartney Mfg. Co. (an Ingersoll-Rand Div.) in Baxter Springs, Kans. There, engineers ran corrugated board, plasterboard, chipboard, rubber, foam, even plywood under the amazingly versatile jet. It zipped through them all and left a narrow, razor-sharp cut; no dust, fuss, splatter, or chips.

You can do the same work with saws, slashers, knives, and similar tools; but the water jet brings big advantages:

- No crushing, squeezing, or deformation.
- No tool pressure to resist; clamps needed only to locate the workpiece.
- No entry hole or cut. Cutouts can start anywhere in workpiece.
- No sharpening. The water "blade" never dulls.
- Straight-through cuts; edges don't distort as they do under blades.
- Waste is carried away with the water or sucked away by air stream.
- Almost no kerf, much narrower cut than with the average mechanical cutters.

These abilities are almost self-evident if you think of the tremendously powerful water jet as a concentrated beam like a laser. In fact, the Alton Boxboard Co., experimenting with techniques to cut heavy paperboard for furniture, tried a laser. The water jet was cheaper, and better—it didn't char the edges.

And the jet can cut a square or sawtooth corner, sharp, right to the peaks. Saws, even with narrow blades, need turning radius. The jet doesn't have to be backed out of a cut; you can start, stop, go in any direction.

How it works. High pressure is the heart of the jet cutting system. McCartney has long experience producing extreme high-pressure pumps. They've even made fantastically powerful, and remarkably precise, presses for the formation of industrial diamonds.

The 70,000 pounds behind the jet starts with a 40-hp motor driving a conventional, multi-plunger, swash-plate-type Vickers hydraulic pump. Oil under pressure from this pump feeds the intensifier. Hydraulic pressure acts on a big piston and alternately shuttles two much smaller pistons to concentrate great pressure on the water in chambers at each end of the intensifier.

This is a reciprocating action; water pressure would rise and fall if it went directly to the jet. Hence, an accumulator between intensifier and jet reduces pressure fluctuations to about 1000 psi. High-pressure water comes

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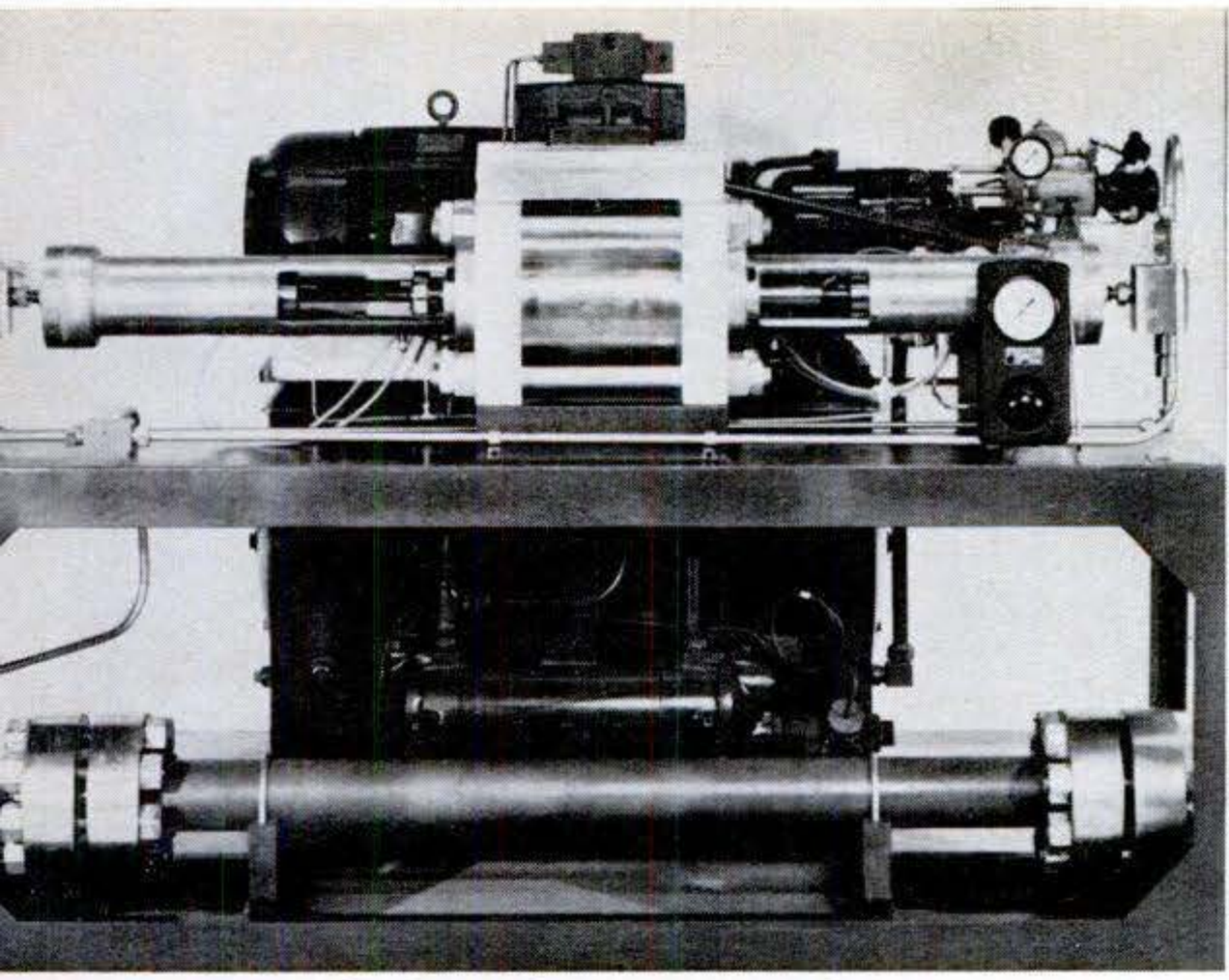
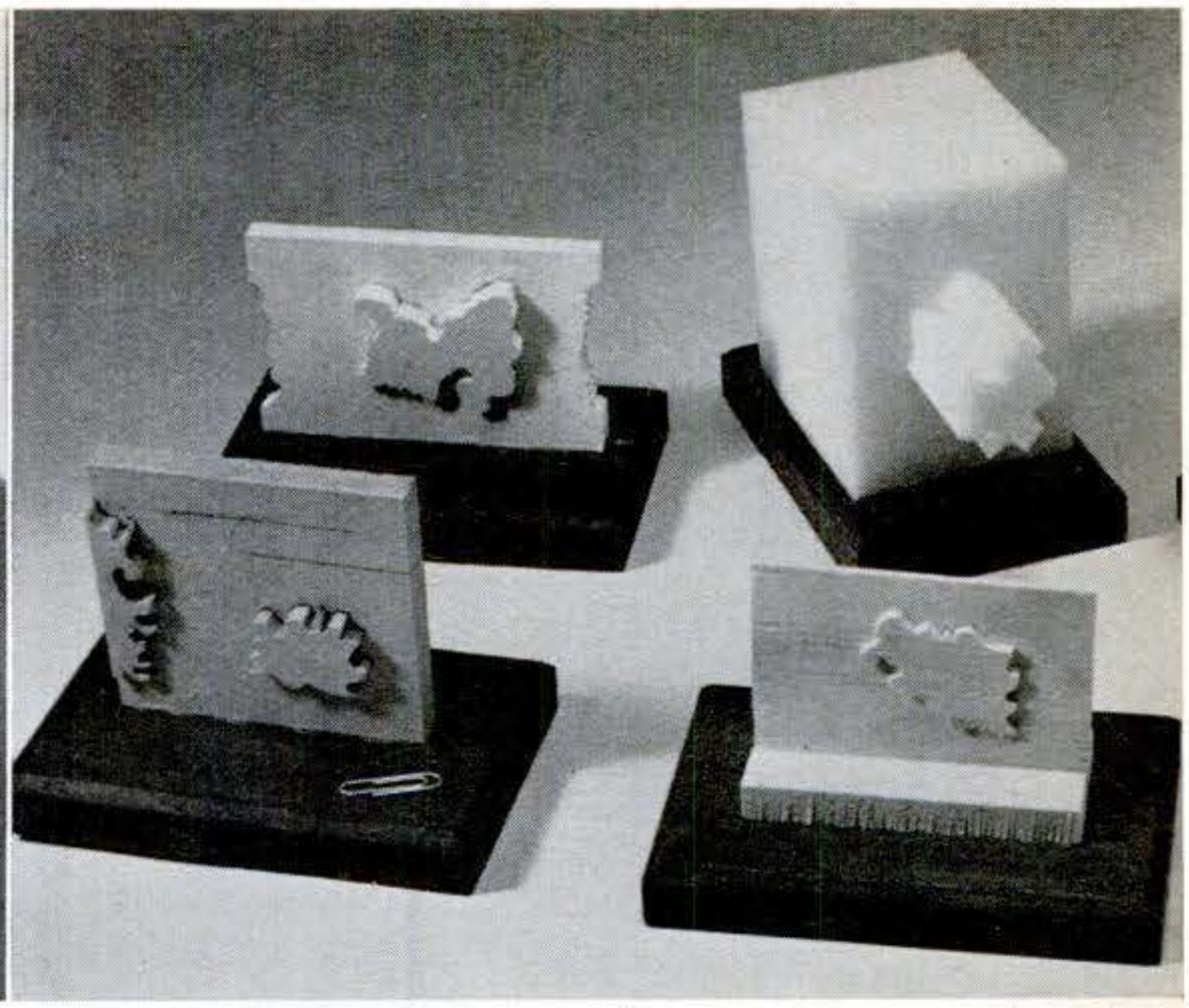


Pressure intensifier has 40-hp motor driving hydraulic pump in the rear, which feeds central shuttle piston. Rams at right and left force water into an accumulator (large tube at bottom).



Intricate cuts—if you want 'em, the water jet can produce them. Notice the zero turning radius and extremely narrow kerf cut through difficult materials like the foam and fiberboard here.

Water! A needle-sharp jet of water can outcut saws, knives, even laser beams

to the nozzle through an air-operated valve that permits instant start and stop of the jet.

Jet-nozzle sizes range from .002″ to .015″. Orifices are highly accurate holes in sapphire, a material which, so far, has shown no detectable wear. This is surprising, since the water leaves the nozzle at over 2200 feet per second.

McCartney doesn't make complete cutting machines—the possibilities are too wide and too specialized. Basically, contour cutting to any desired shape can be done at rates up to 50 feet per minute. This depends, in part, on how fast the machine can move the jet around the workpiece, or the workpiece under the jet.

In straight cutting, trimming heavy corrugated board, for example, speeds range up to 500 feet per minute. The board zips under the jet and is cut faster than the eye can follow. Speeds over 60 mph are possible for continuous, roll-fed newsprint paper.

In all cases—paper, plywood, rubber, foams, plaster, fabrics, or abrasive papers—the cutting leaves no dust or debris. Most dust is entrained by the jet and carried to the discharge collector. Scrap becomes a slurry—a simple disposal problem.

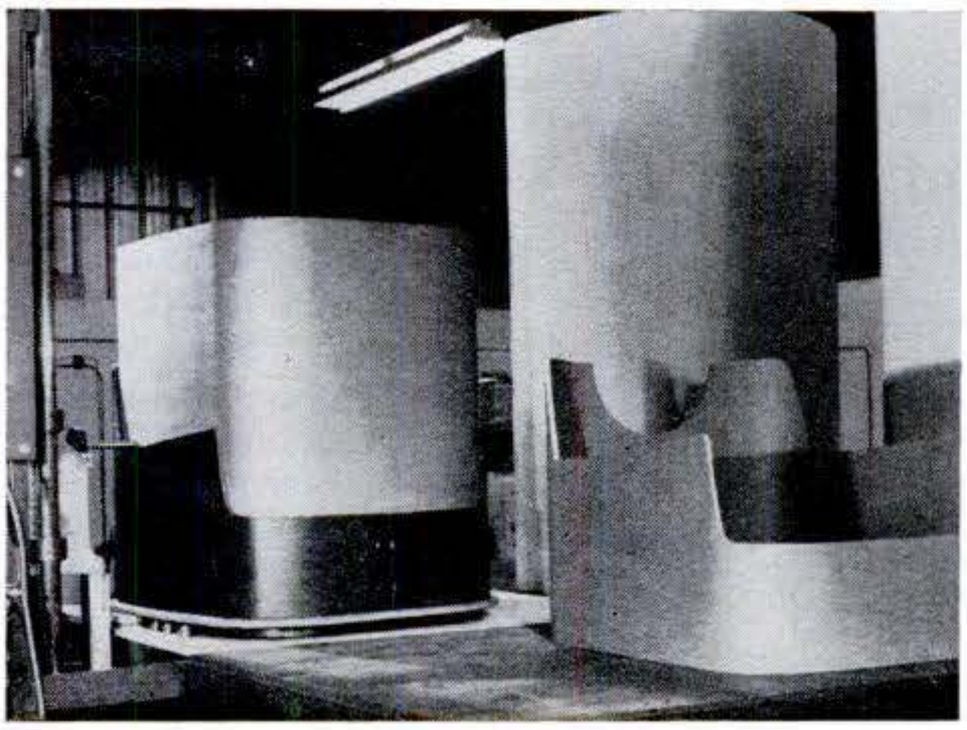
The volume is small. At low pressure (40,000 psi) waste water is 50 gallons an hour; at 70,000 psi it's only 25 gph. Remember, this is water from which solids could be filtered if necessary. The water does, however, carry a small amount of a biodegradable additive that is the real secret of the jet's success.

Magic polymer: Plain water would emerge from the nozzle in a cone, not the necessary needle-sharp jet. McCartney engineers ran the cutter for me with straight water and it was evident that the flared-out discharge would be a poor cutting tool.

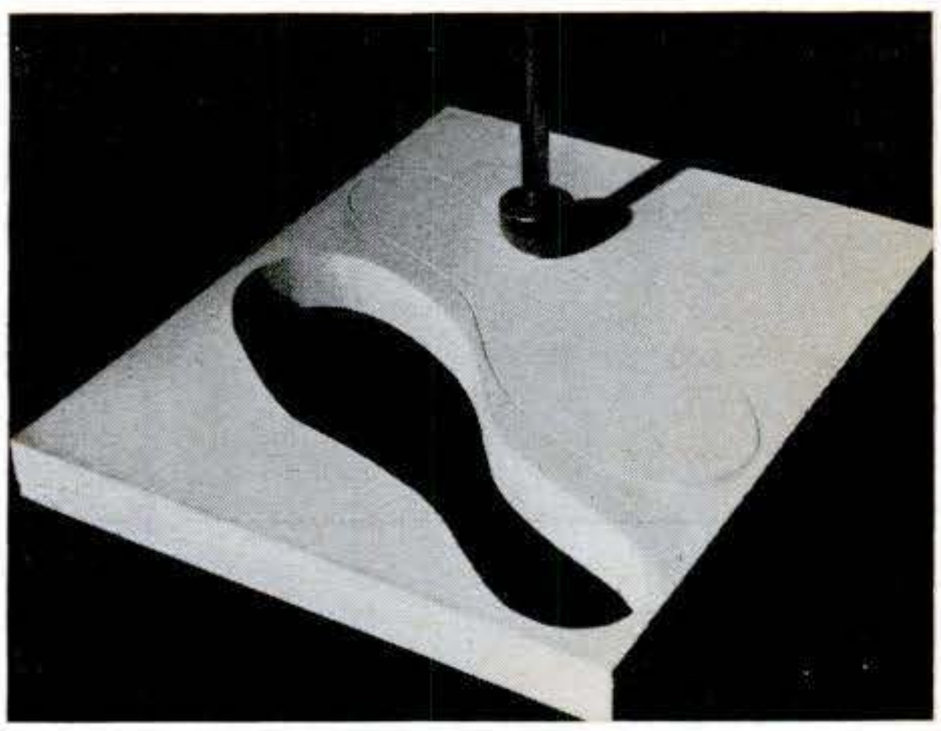
A turn of a valve switched over to water mixed with a small amount of a long-chain, nontoxic, noncorrosive polymer. Almost instantly the jet envelope changed from fan-shaped to wire-like. McCartney doesn't say much about the polymer except that it shouldn't be a pollution problem.

How practical is water-jet cutting? While I was at the McCartney plant, engineers from some giant firms were also visiting. The file of investigators of jet cutting fattens daily. I saw exotic materials from the electronics industry, cellular structures from aircraft, asbestos and like materials with hazardous dust, and squishy stuff like eight-inch foam rubber that squirms under mechanical cutters. All yielded cleanly to the powerful jet.

I suggested that it might be a dandy way to slice carrots, beets, or potatoes. The McCartney people smiled and said it had been considered, but right now they're busy for years to come. PS



Foam rubber soles for shoes can be cut at 50 feet per minute (no pun intended). Linear speed of jet is fast if the guide system can follow the shape to be cut.



First production use of jet cutting is at Alton Boxboard (left). Dense, laminated paperboard for furniture is cut quickly under jet guided by template at far left.

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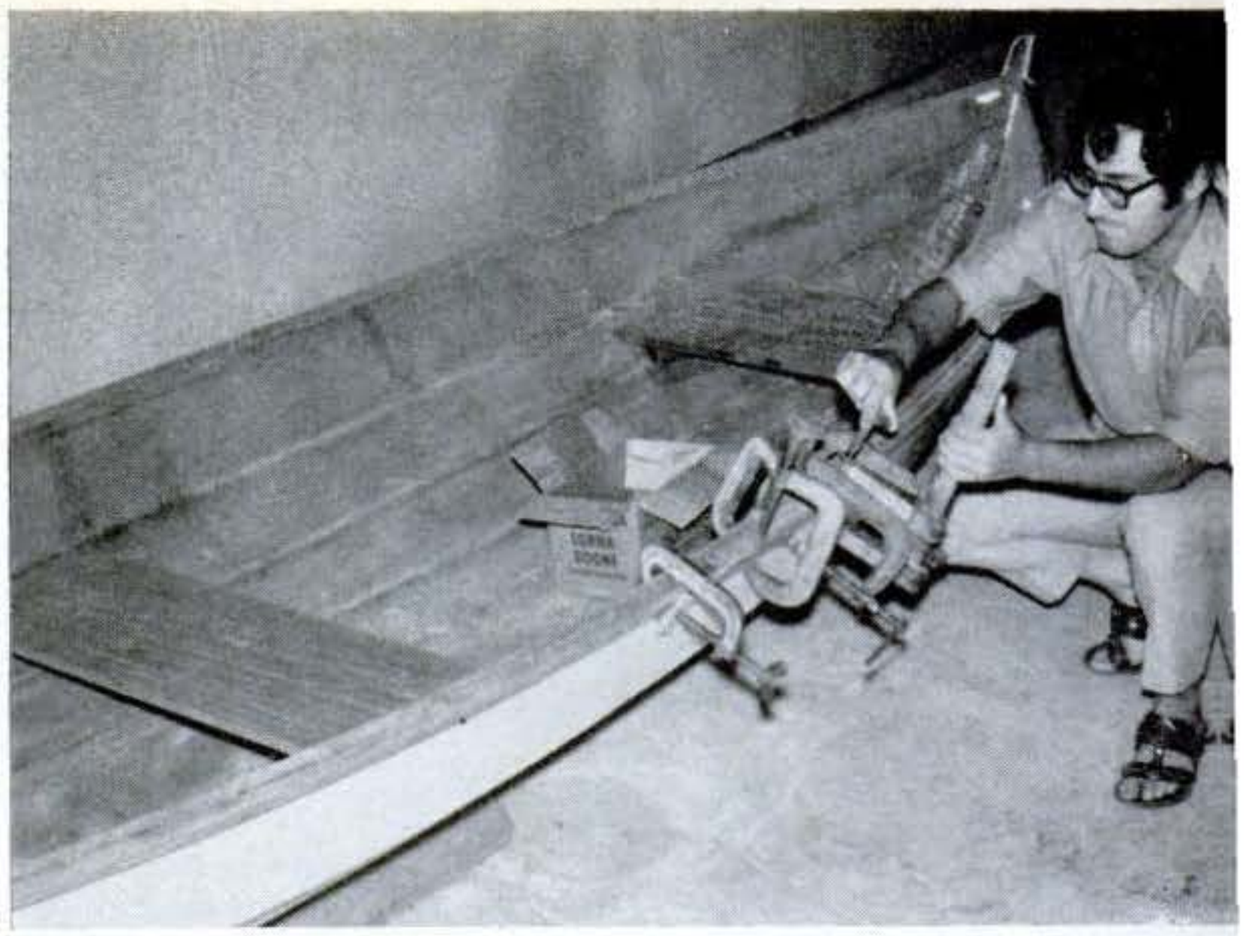
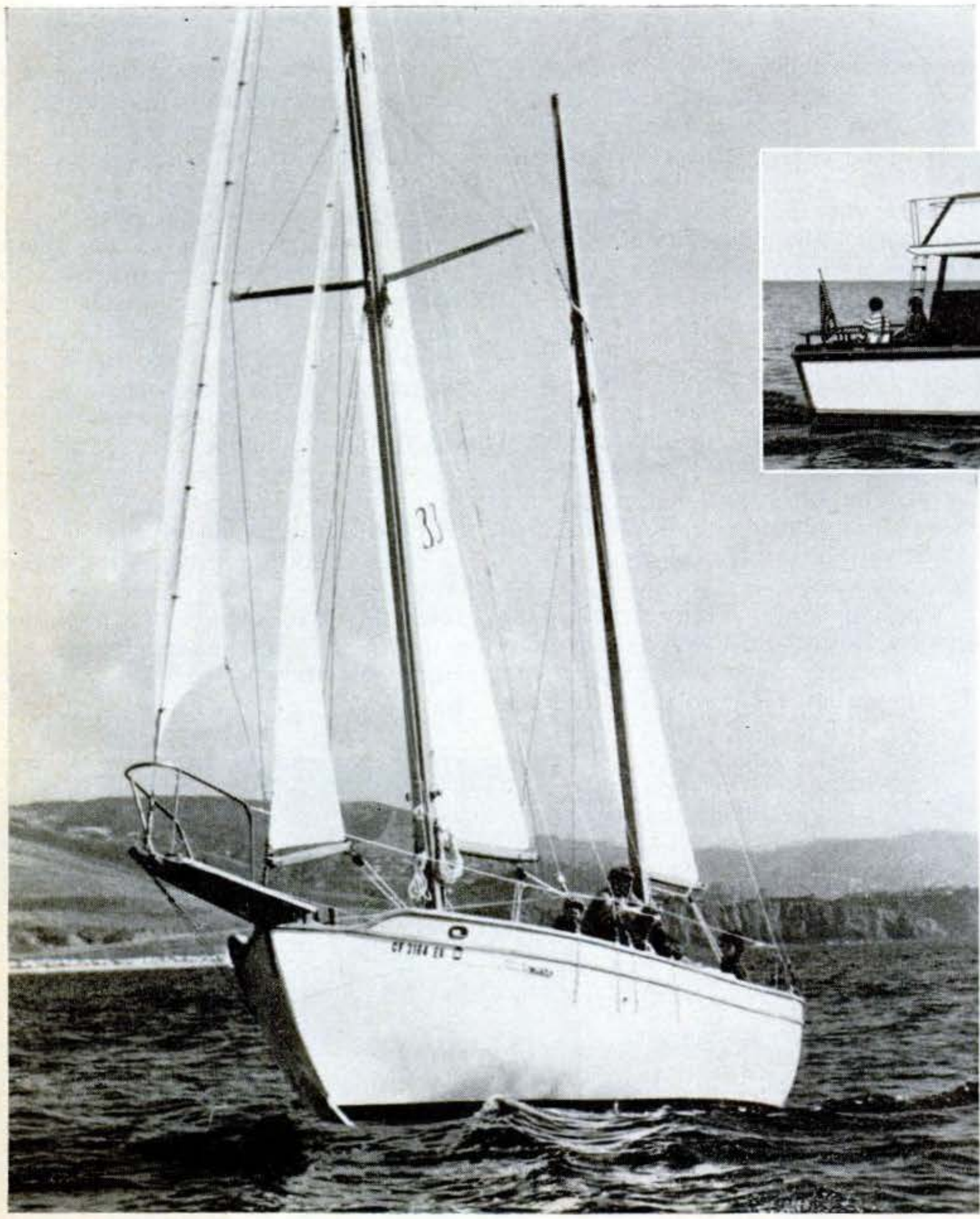
Sailcrafter 28, a popular light-displacement racer, is available as a prefabricated kit or in various stages of completion, from hull and cradle at $1590, to a nearly completed yacht.



Kits aren't limited to big boats—the rowing dory above is only one of many types of small boats offered in kit form. Here a gunwale is being clamped onto a 16½-foot Dreadnought. Cost? $185.

Build It Yourself



World cruising? The Westsail 32 at left can do it. A kit costs from $2063 up, depending on how much of the building and assembly you're willing to do yourself.

Basic kit for 32-foot Coronado, above, costs $3995 (minus engine and accessories). Luger makes it, and can supply engine kits and accessories to go with it.

It's more than saving money —you end up with a boat crafted to match your dreams

By JACK WILEY

From a small dinghy to a world cruiser—power, sail, or combination—today you can get it in kit form. Fiberglass boat kits are not new. What is new are the number and types and designs available, in completely prefabricated packages and off the drawing boards of such designers as Lapworth, Crealock, McGlasson, Hanna, and Tripp.

Leading companies like Morgan, Columbia, Coronado, Islander, and

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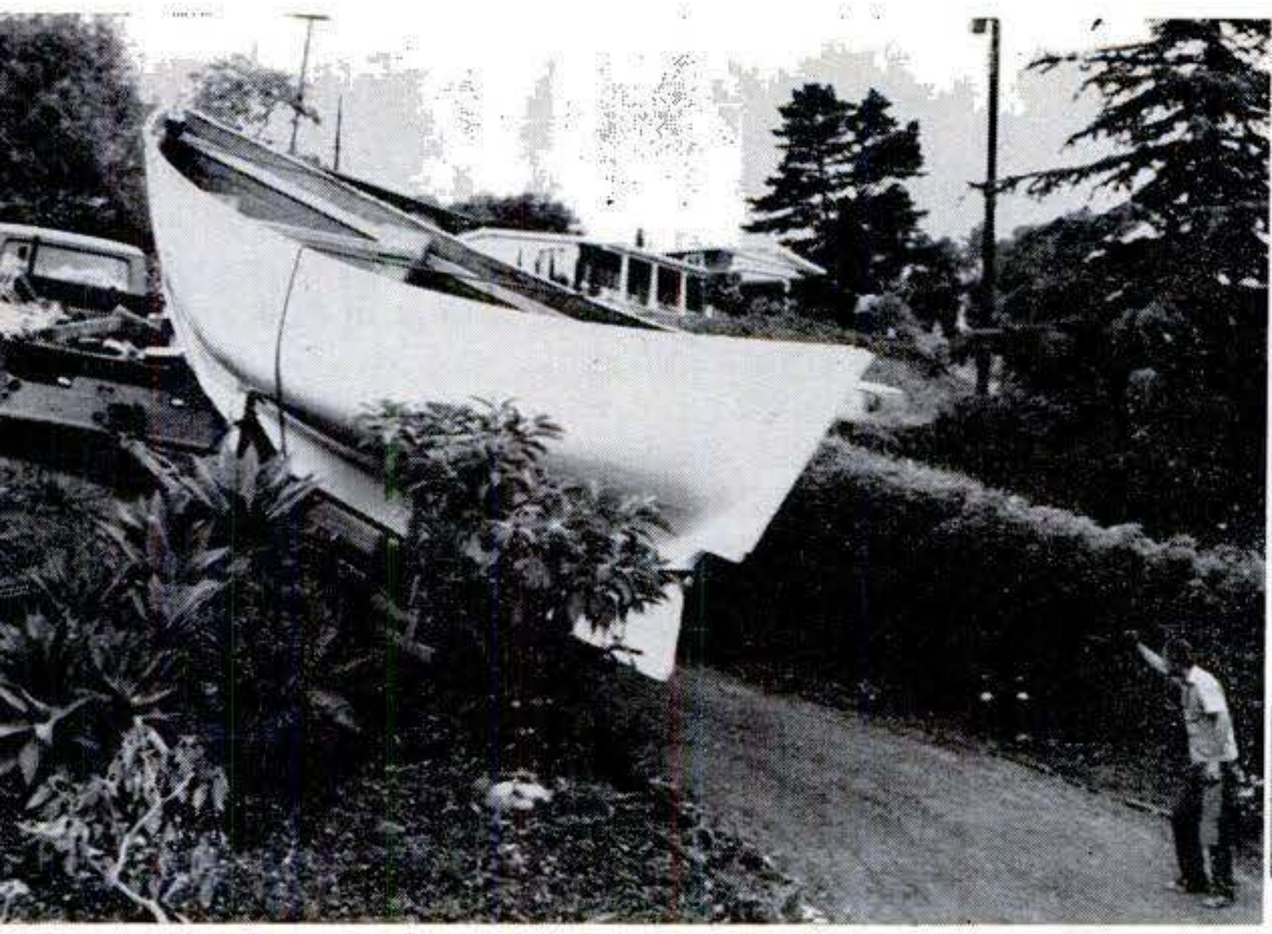
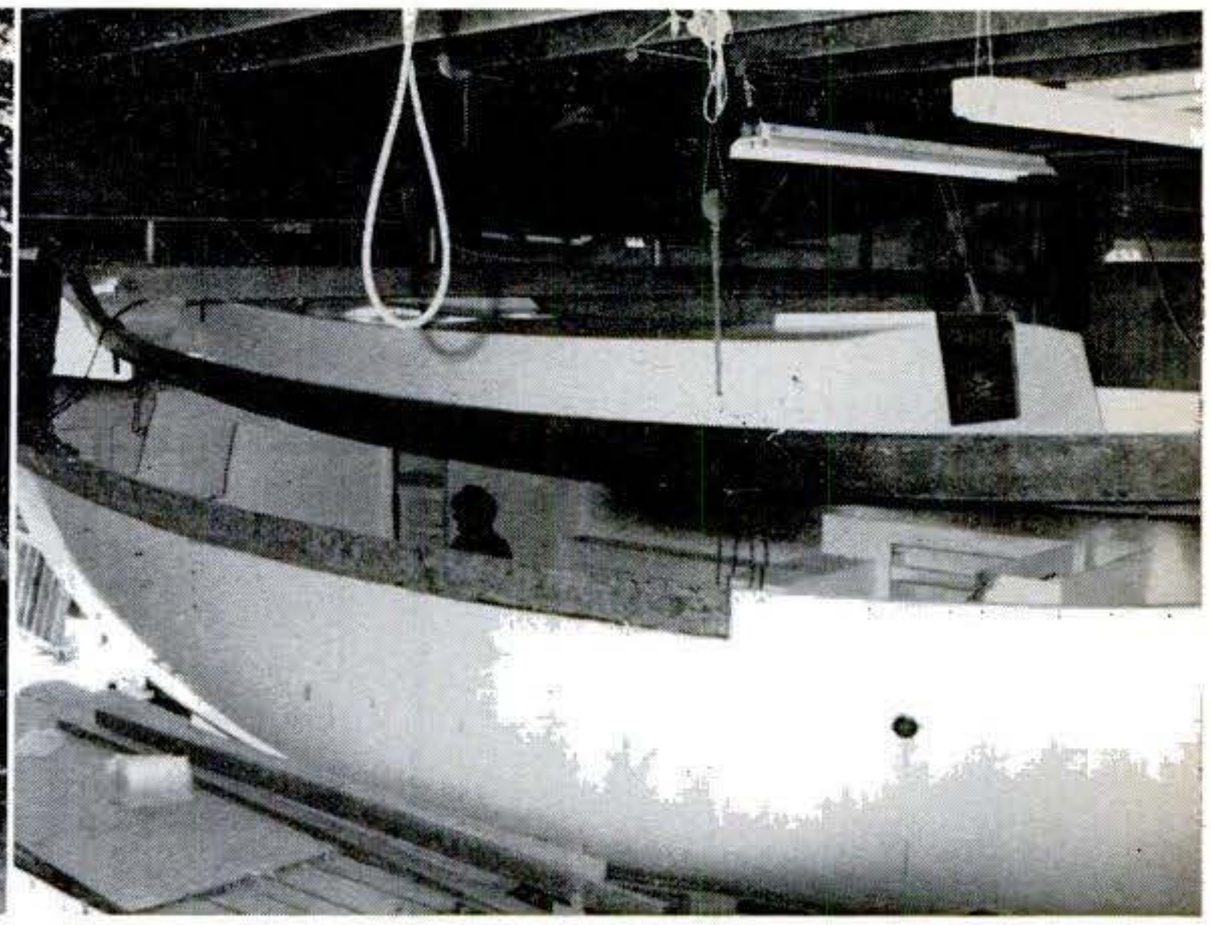


Hull for 32-foot Dreadnought is a tight fit in this driveway. If you plan to put your boat together in your driveway, before you buy it take careful measurements to make sure it'll fit.



Deck and cabin structure are separate from the hull when you buy a basic kit. Before you assemble, read the instruction manual thoroughly to make sure you do everything in the right sequence.

and Get Twice As Much Boat

Spencer, to name a few, have gotten into the kit field, and will now sell you parts for a complete boat, built to the same standards (and often from the same molds) as their finished boats.

Even two world-famous sailboats (both ideal for living aboard and world cruising) are now available in fiberglass and in kits: the Westsail 32, a trunk-cabin descendant of the Colin Archer design with a modern sail plan and interior accommodations, and the Dreadnought 32, a modern version of John Hanna's famed Tahiti ketch.

Within a year from the time the first Dreadnought 32 hull came out of the mold, 17 builders had started work on this dreamboat. The first of these, launched not long ago in San Francisco, has already made an ocean passage to Hawaii.

Why the big boom? Two things bring popularity to kit fiberglass boats. Money—a saving of from 30 to 60 percent of the price of a factory-completed equivalent—and the possibility of custom-tailoring a boat to your needs. This is particularly true of the interior, where you'll have the freedom to build accommodations the way you want them, without changing the performance or safety of the vessel. It's an opportunity to get away from the typical berth-stuffed factory model.

And, of course, a kit has it all over building a boat from scratch, in several ways.

First, time: You can spend several years doing it all yourself. And at some point, often with the end nowhere in sight, the amateur may give up. Not so with the kit builder. The hardest part of any boat to build, the hull, is already completed, and all guesswork for finishing the boat has been eliminated. A large boat built from the ground up often ends in disaster. The one built from a modern prefabricated kit almost never does. Your second benefit: price.

How much can you save? Let's look at some examples:

Trailcraft offers a 13½-foot molded fiberglass kayak in kit form for $89. The factory-finished equivalent would be about $180. Also available is a 14-foot canoe kit for $129, an 18-footer for $144, and a 12-foot crossbreed canoe boat for $119. All these are complete kits and you even get your choice of colors. In each case, by doing your own assembly and finishing, you save about 50 percent.

A complete kit for assembling the Flying Cloud, a 14-foot sailboat from Luger Industries, is $299.50. And this includes an aluminum mast and dacron sail. A factory-finished equal costs over $500. Even larger savings are possible on Luger's 15-, 17-, and 20-foot sailboats.

Luger Industries also offers a complete line of powerboats, starting with the 14-foot Jamaican, which comes as a complete kit (less outboard motor). About $400, it is comparable to factory-finished craft priced at $800 and up.

For the really ambitious, Luger also has a number of larger fiberglass powerboats, all in prefabricated kits, up to the 32-foot Coronado, for which the basic kit (less engine) is a healthy $3995.50. Still, that's less than half the cost of a factory-completed equivalent.

For a larger-size boat, a basic hull kit usually costs less than the down payment on a boat off the ways. Then you can purchase the other component packages as you need them and can afford them. (Except for very small boats, most manufacturers divide their kits into a dozen or more separate packages.)

Got any skills? You don't have to buy all of the component packages. You can supply your own materials and use any special skills you have (woodworking, machining, upholstering, or whatever) in place of one or more component kits.

Continued

Yachtcraft rigging, shown being installed, comes in one of the more than a dozen component packages that Yachtcraft can supply to go with their boat kits.

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Interior of Sailcrafter 22 looking forward shows large stateroom, modern dinette seating arrangement, galley with water tank and pump, four full-length berths.

Using this method, it is possible to save even more money. For example, by purchasing only the basic hull kit for a 32-foot Tahiti ketch, which sells for $3800 (Dreadnought Boatworks), and supplying your own materials and equipment for finishing her, you can have a $25,000-$30,000 world-cruising yacht for $12,000.

Or you can have a floating home, like some kit builders. Jack Wilkin of Venice, Calif., finished a Westsail 32 to the point where she could be launched. He is now living aboard with his wife and dog in Marina del Rey while he finishes the interior.

How much skill does it take? Not much, providing that you use all of the component packages for completing the boat. In fact, assembling one of the small boats that come in complete kits makes an ideal father-son project, or even a family project.

Richard Newlean of Vancouver, Wash., and his two sons, Bill and Dave, took most of a year turning their Cascade 42 hull (Yacht Constructors, Inc.) into a beautiful sloop. It was a year in which working on the boat became a way of life. But that year was only the beginning: The cruising came after that.

For larger boats, if you tackle some of the building on your own (that is, shaping parts instead of merely assembling them), considerable skill is required. And, of course, it will take longer. Certainly the savings will be greater if you do some of the building—so you'll have to decide which jobs you want to tackle completely on your own and which ones you want to use component packages for.

What tools do you need? For most assemblies, besides the basic hand tools, you'll want a portable electric drill, a sander, and perhaps a saber saw. If you bypass component packages and take on some of the construction steps, you'll need more specialized tools.

What about a building site? A good place for building a small boat is your garage; and for a large boat, your yard or driveway. But then make sure there's room to get the boat in and out. And don't forget you'll need several feet of open space all the way around the hull.

No garage, no yard? You can also borrow or rent a building site. An ideal arrangement is to rent space in a do-it-yourself boatyard. These are now found in most parts of the country and charge about 75 cents to $1.50 per foot of boat per month. The typical yard supplies electricity, water, and compressed air, and generally tools and heavy equipment are on hand for rent also.

It's usually more convenient—and more comfortable—to build under

[*Continued on page 124*]

WHO MAKES WHAT

The list below includes only companies that offer fiberglass moldings for a complete boat in kit form on a regular basis. Many other companies will sell bare hulls and components from their line on special request. Prices (below and in the article) are intended only as approximations at the time of writing, and, along with specifications, are subject to change. In most cases prices are F.O.B. from the factory.

Dreadnought Boatworks, P.O. Box 221, Carpinteria, Calif. 93013
- 16'6" Norwegian rowing dory (bare hull, $185; no components available).
- 32' cruising (Tahiti ketch) sailboat (basic hull, $3800; deck, $2000; other components available)

Easterly Yachts, 1729 Lake Ave., Box 9104, Metairie, La. 70005
- 30' basic sailboat (hull and deck bonded together with 4 basic bulkheads in place; furnished loose are 3 hatches, 8 windows, rudder, $4250; other components available).

Glander Boats, Inc., R.R. No. 1, Box 140, Tavernier, Fla. 33070
- 23' sailboat (hull, deck, and cabin, $3100; other components available).
- 33' sailboat (hull, deck and cabin, $5400; other components available)

Hughes Marine Sales (Huron Park) Limited, Huron Industrial Park, Huron Park, Ont.
- 25' sailboat (bare hull, $1500; deck and cabin, $700; other components available).
- 38' sailboat (bare hull, $5000; deck and cabin, $3000; other components available).
- 48' sailboat (bare hull, $7850; deck and cabin, $4550; other components available)

Lakeview Boat Co., Box 5595, Riverside, Calif. 92507
- 15' canoe (complete kit, $130)
- 17' canoe (complete kit, $140)
- 13' kayak (complete kit, $100)

Luger Industries, Inc., 3800 West Highway 13, Burnsville, Minn. 55378
- 14' sailboat (complete kit, $299)
- 14' outboard (complete kit, less motor, $399)
- also 15', 16', and 20' sailboats and 17', 20', 22', 24', and 32' powerboats; accessories also available

McCutcheon Boat Works, Ferry Ave., Charlevoix, Mich. 49720
- 30' racing/cruising ketch (bare hull, $3000; other components available)

Ron Rawson, Inc., 15014 N.E. 90 St., Redmond, Wash. 98052
- 30'6" sailboat (all fiberglass components, $5200)
- 32' powerboat (write for prices)

Sailcrafter Yachts (Columbia & Coronado Yacht Corp., 275 McCormick Ave., Costa Mesa, Calif. 92626)
- 22', 23', 25', 28', 36', 50', and 57' sailboats (all materials are furnished for completion; any stage of completion from hull only to near-finished boat; write for prices and specifications).

Sailing Kit Kraft (Morgan Yacht Corp., P.O. Box 13247, St. Petersburg, Fla. 33733)
- 22' sailboat (bare hull, $1254; other components also available)
- 25', 30', 33', 34', 35', 40', and 41' sailboats (write for prices and specifications)

Seafarer Fiberglass Yachts, Inc., 760 Park Ave., Huntington, N.Y. 11743
- 7'1" dinghy (rowing model, $168; sailing model, $297)
- 23' sailboat (hull, $950; other components available)
- 24', 26', 28', 31', 34', 38', and 48' sailboats (write for prices, specifications)

South Coast Seacraft, Inc., P.O. Box 1674, Shreveport, La. 71102
- 21' sailboat (hull and deck assembled, $1595; other components available)
- 22' sailboat (hull and deck assembled, $1595; other components available)
- 23', 25' and 28' sailboats (write for prices and specifications)

Spencer Boats, Ltd., 1240 Twigg Rd., Richmond, B. C.
- 31' sailboat (hull, $3268; hull, rudder, lead ballast in place, fuel and water tanks molded in, $4985; other components available)
- 35', 41', 42', 44' and 51' sailboats (write for prices and specifications)

Trailcraft, Inc., P. O. Box 606, Concordia, Kans. 66901
- 13'6" kayak (complete kit, $89)
- 12' crossbreed canoe (complete kit, $119)
- 14' canoe (complete kit, $129)
- 16' canoe (complete kit, $134)
- 17' canoe (complete kit, $139)
- 18' canoe (complete kit, $144)

Vineyard Yachts, Inc., Beach Rd., Vineyard Haven, Mass. 02568
- 21'7" powerboat (basic hull, $2000; deck and cabin, $1100)
- 32' powerboat (basic hull, $4200; deck and cabin, $1900)

Westsail Corp., 177 Monrovia Ave., Costa Mesa, Calif. 92626
- 32' cruising sailboat (hull with main and engine room bulkheads, $4200; trunk-cabin deck with cockpit, without trim or windows, $2063; other components available)

Yacht Constructors, Inc., 7031 N.E. 42nd Ave., Portland, Ore. 97218
- 29' Cascade sailboat (bare hull, $1775; other components available)
- 36' Cascade sailboat (bare hull, $3650; other components available)
- 42' Cascade sailboat (bare hull, $4950; other components available)

Yachtcraft (Islander Yachts, Inc., 1682 Placentia Ave., Costa Mesa, Calif. 92627)
- 23' swing-keel sailboat (hull, cradle, deck, $1145; other components available)
- 24', 26', 27', 29', 30', 32', 33', 37', 40', 44' and 55' sailboats (write for prices and specifications)

Yorktown Yachts, 700 Henry Ford Ave., Long Beach, Calif. 90813
- 33' and 35' cruising sailboats (write for prices and specifications)

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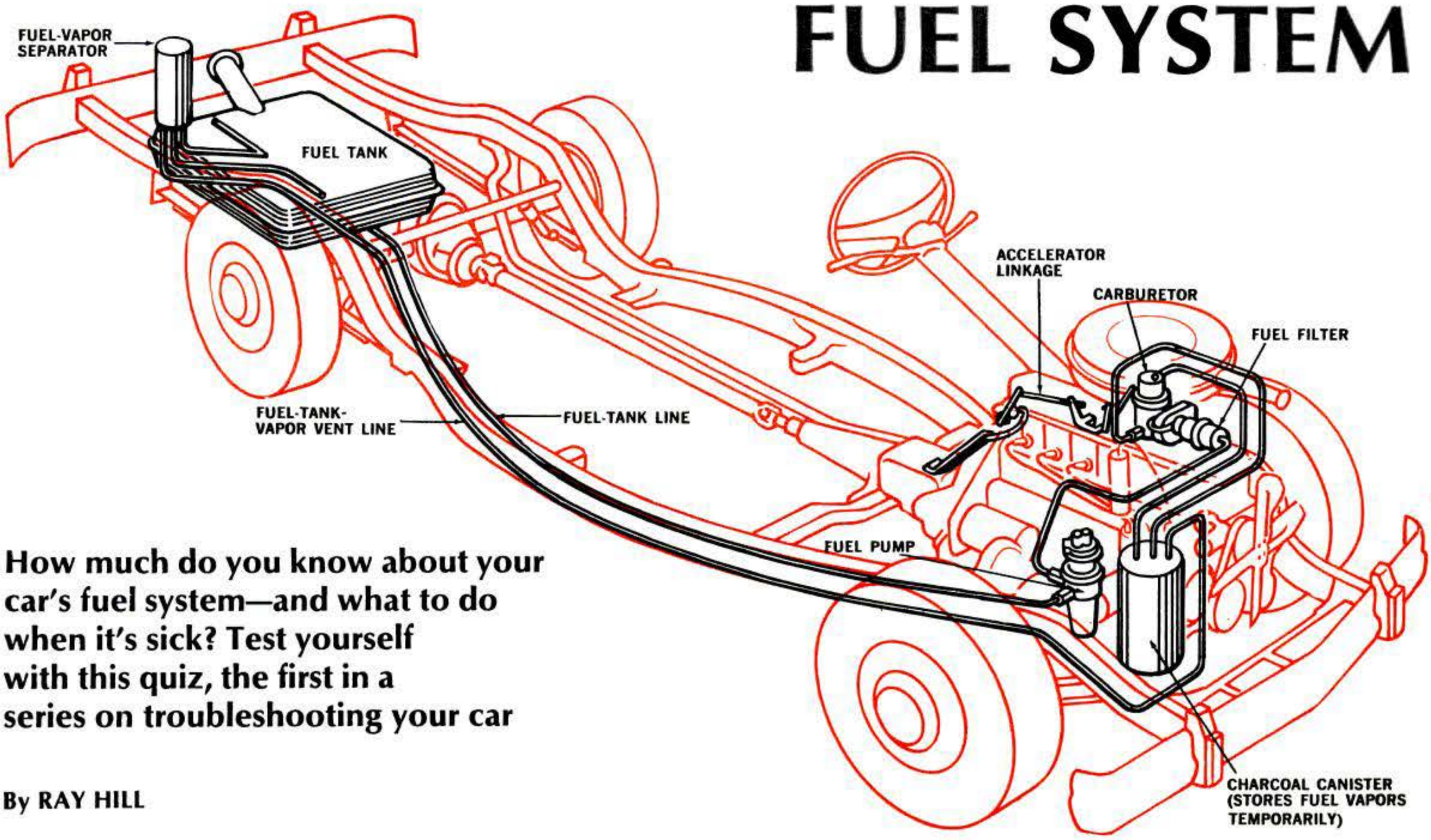
A typical fuel system consists of fuel tank, fuel lines, fuel pump, fuel filter, and carburetor. The pump draws gas from the tank and forces it through the filter into the carburetor. The carb meters the fuel and injects it into the air stream. This air-fuel mixture is then drawn into the engine by the vacuum created as the pistons move down in their cylinders. In late-model cars, the fuel system is closed, preventing gasoline from evaporating into the atmosphere. Vapor from the gas tank leaves through a vapor separator and is routed to the engine, where it's burned.

Troubleshooting Your Car's FUEL SYSTEM



How much do you know about your car's fuel system—and what to do when it's sick? Test yourself with this quiz, the first in a series on troubleshooting your car

By RAY HILL

1 Engine dies, won't restart

Two days ago you drove your car to the garage for a tuneup. Points, spark plugs, and condenser were replaced, everything was adjusted to correct specifications.

Last night as you drove away from the garage you were impressed with the engine's improved performance. Then, on the way home, you had to detour around some road construction. You hit a deep pothole, scraping the car's underside, but there was no apparent damage to the car, and the engine continued to run smoothly.

This evening as you and your wife are driving home from a movie the engine suddenly dies. You let the car coast to a stop and try to restart it. The engine turns over, but won't fire. The gas gauge reads quarter-full. Puzzled, you get out of the car and raise the hood.

First, you check the distributor to see if it's loosened, permitting the ignition timing to change. It's tight, so you assume the timing's still okay. Pulling a high-tension wire from one of the spark plugs, you hold it close to the plug as your wife hits the starter. A healthy spark jumps the gap. Cranking, electrical supply, and ignition systems apparently are working properly.

Next you disconnect the fuel line from the carburetor. Your wife hits the starter again. The engine turns over, but there's no gas coming from the fuel line.

Now you're getting somewhere! At the fuel pump you disconnect the line from the gas tank and blow through it to check for obstruction. Surprisingly, you hear air hissing smoothly into the gas tank instead of bubbling through gasoline. Your startled conclusion: The gas gauge is giving an inaccurate reading and the gas tank is empty. What happened?

2 Poor idling

The spark is hot, a quick check with your strobe tells you that the timing is okay, and your compression tester and vacuum gauge show that the valves are in good shape. Plugs are clean and gapped to spec, but still your engine idles poorly.

That leaves the fuel system. First, a general check.

The screws that hold the carburetor's main body to the throttle body are tight, so probably no air is slipping in to change the fuel mixture. To make sure, you squirt a little gasoline around the joint, from an oil can, while the engine's running. It doesn't speed up, so there's no leak.

The carburetor is securely bolted to the intake manifold, and there's no air leak there, either. Adjusting the idle-mixture screw or screws doesn't help. The problem must be on the inside.

You get out your shop manual, and following its directions carefully, you remove the carburetor from the manifold and take it over to the workbench. As you begin disassembly, you check the idle air bleed to see if it's carbonized or dirty. It's okay. The idle discharge holes are clean. The

Continued

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throttle body isn't carbonized, and the throttle shaft isn't worn—so they can't be causing the trouble.

You check the float to see if it's maintaining the proper fuel level in the float bowl (your service manual gives proper specs). It is. The float needle valve and seat aren't corroded. Frankly, you're befuddled.

What have you overlooked?

3 Poor acceleration

You step on the gas pedal to pass another car, but instead of surging forward, your car picks up speed gradually. You don't like remaining out in the passing lane longer than necessary, so you pull off as soon as possible to look for the trouble.

Standard valve and ignition checks reveal nothing, so the prime suspect is the accelerator pump. When you depress the accelerator pedal to pass another car, the accelerator pump should spray additional fuel into the air stream passing through the carb. That's so you'll get instant acceleration and won't have to wait a few seconds until the fuel flow can catch up with the engine's increased fuel demands.

To your surprise, you find that the accelerator pump is adjusted correctly and that the accelerator pump-inlet check ball and discharge are functioning. The throttle linkage shows no wear, and the float is okay. You check the manifold heat valve to see if it's sticking. It's not. But something's causing that poor acceleration.

What is it?

4 You smell gas in the engine compartment

You raise the hood and the carb is bathed in gas. A careful inspection reveals no cracks in the carb body; the screws that hold the main body to the throttle body are tight, too. And you can't find any loose gasoline connections. Excessive fuel-pump pressure could be the root of the problem, but since you'd have to take the car to the shop to check it, you assume for the moment that it's okay.

That leaves the carb. As you break it down on your workbench, you check the body gaskets. They're okay. How about a high float level? That could cause a leak. Nope. Float's okay.

What else could cause the leak?

5 Acceleration, idling, general engine performance

Your engine is performing as if it were an out-of-shape boxer trying to make a comeback—badly. The only suspicious sign you find looking over the engine and the rest of the car is the tailpipe. The inside is wet with what appears to be raw gas. Routine valve and ignition checks indicate that everything is okay there; pump pressure seems normal. Prime suspect: the fuel system.

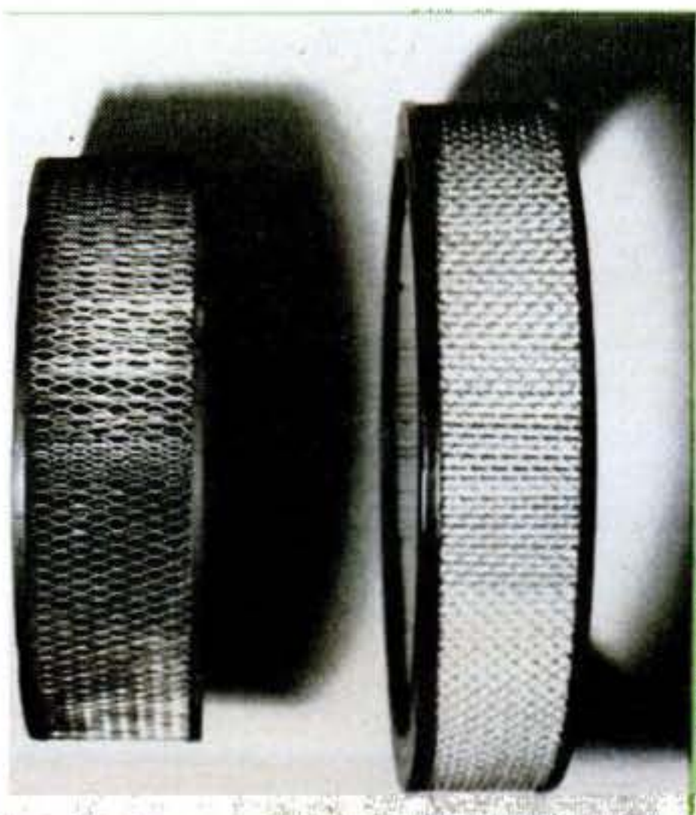
What's the first thing you'd check?

6 Engine won't start

The spark is okay, so the fuel supply is probably at fault. You disconnect the gas-feed line at the carburetor and find that no gas is coming out of the line while the engine is cranking. You disconnect the feed line at the fuel pump and gas pours out when the engine cranks.

Why isn't gas reaching the carb?

Confused? Or confident? Check here to see how your answers compare with what the experts say:

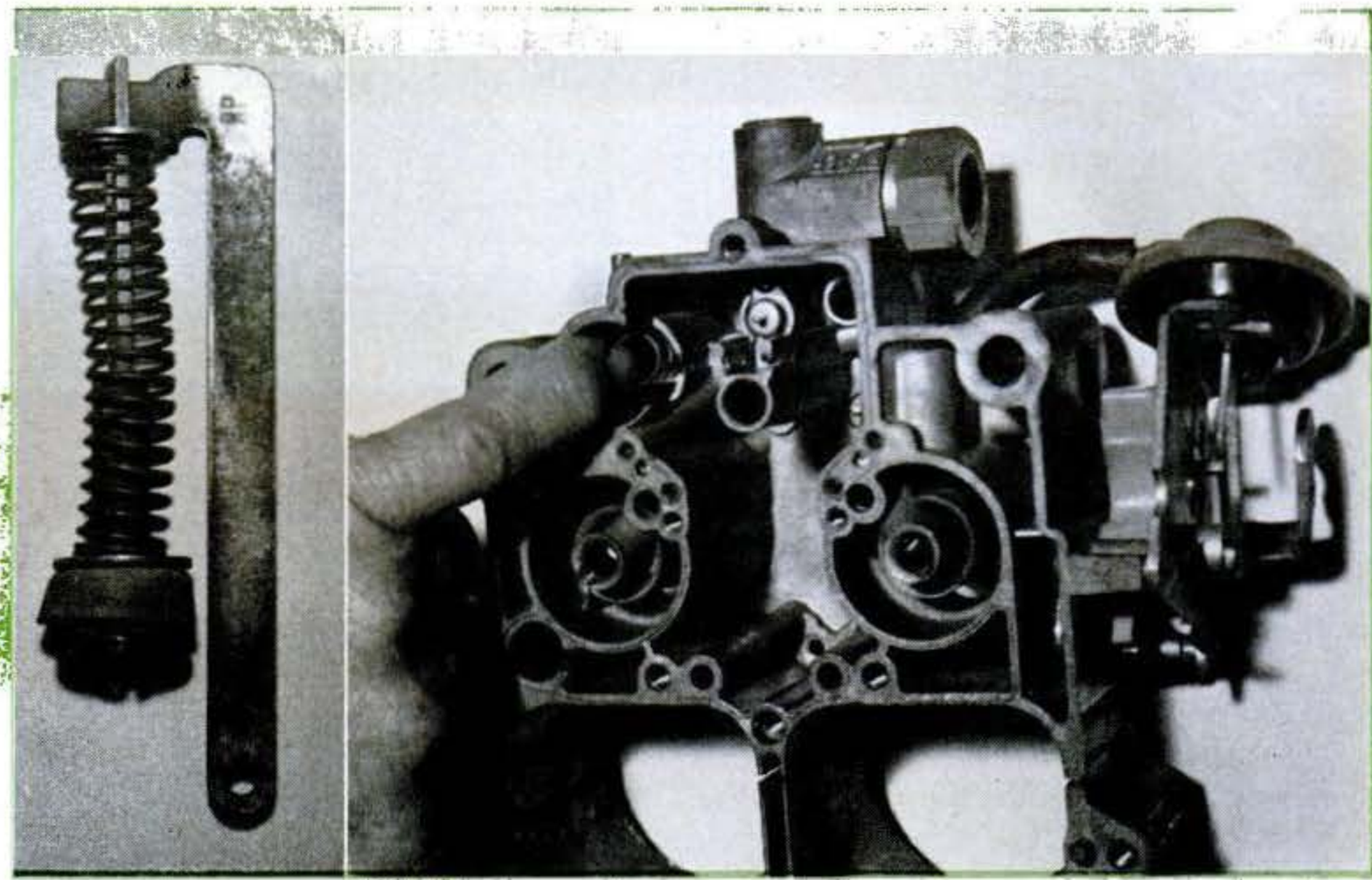


Air-cleaner filter element, left, is dirty. Plugged entirely in some places, it restricts air flow to the carb; should have been removed long before it reached this state. Clean filter at right permits correct amount of air to enter the carburetor.

1 Remember that pothole? It dented the bottom of the gas tank. Your flashlight will show up the scrape marks where it hit the street. Now why your engine died is plain. As the fuel level dropped, the fuel-gauge float in the tank dropped—until it reached the dent and stopped. Gas around the dent continued to drop. But because the float was hung up, the fuel gauge continued to register quarter-full. Solution? As soon as possible get a new gas tank.

2 You've probably overlooked a damaged or worn idle-mixture needle. Replace it. If the throttle body surface is damaged where the needle screws in, replace the body.

3 The accelerator pump piston (or plunger) leather is too hard, worn, or loose on the stem. Replace the accelerator pump assembly.



Accelerator-pump plunger leather (above, left) won't form a good seal when it moves up and down its cylinder in the carburetor. Poor sealing means weak suction, poor acceleration. Pump's return spring should be strong, and should pop back strongly when depressed with a finger (as at right).

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FUTURE QUIZZES:

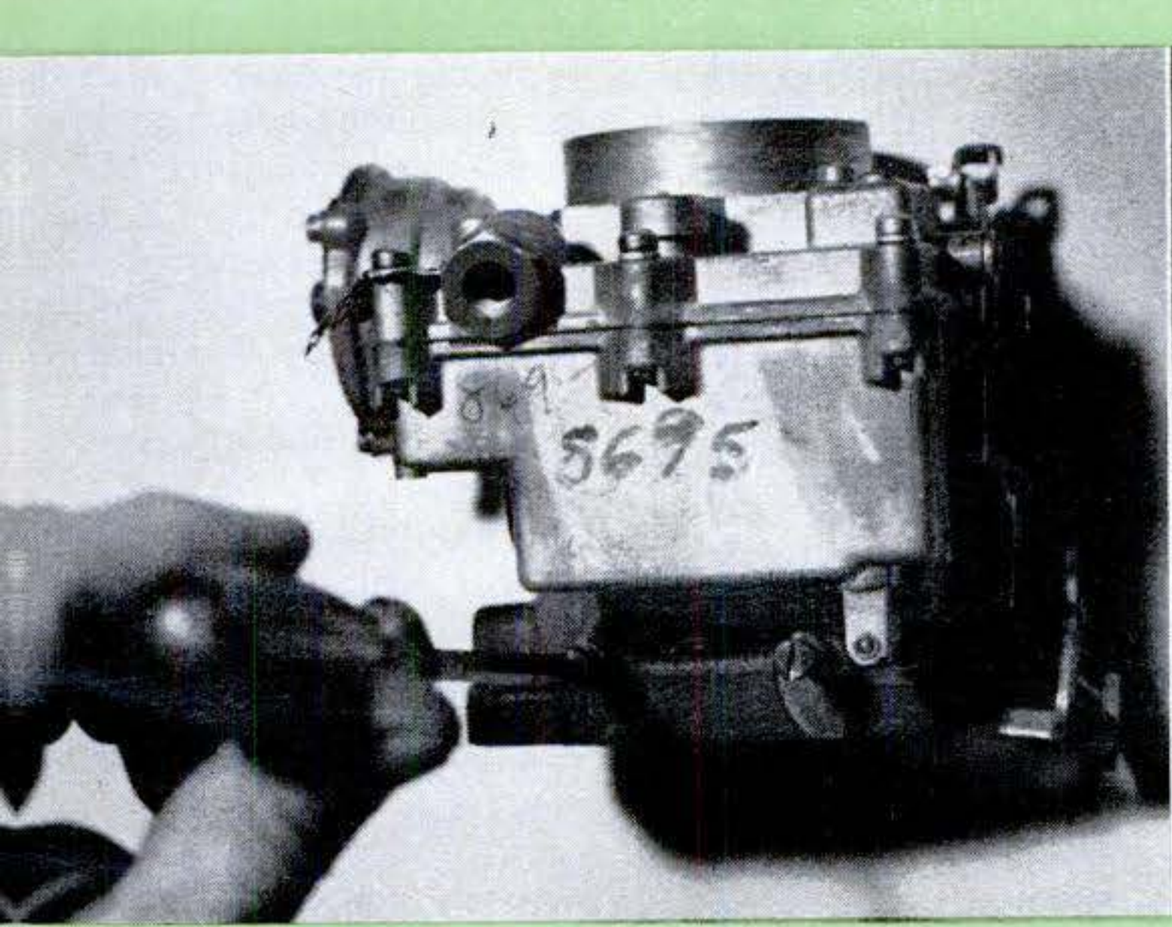
What you can expect from them

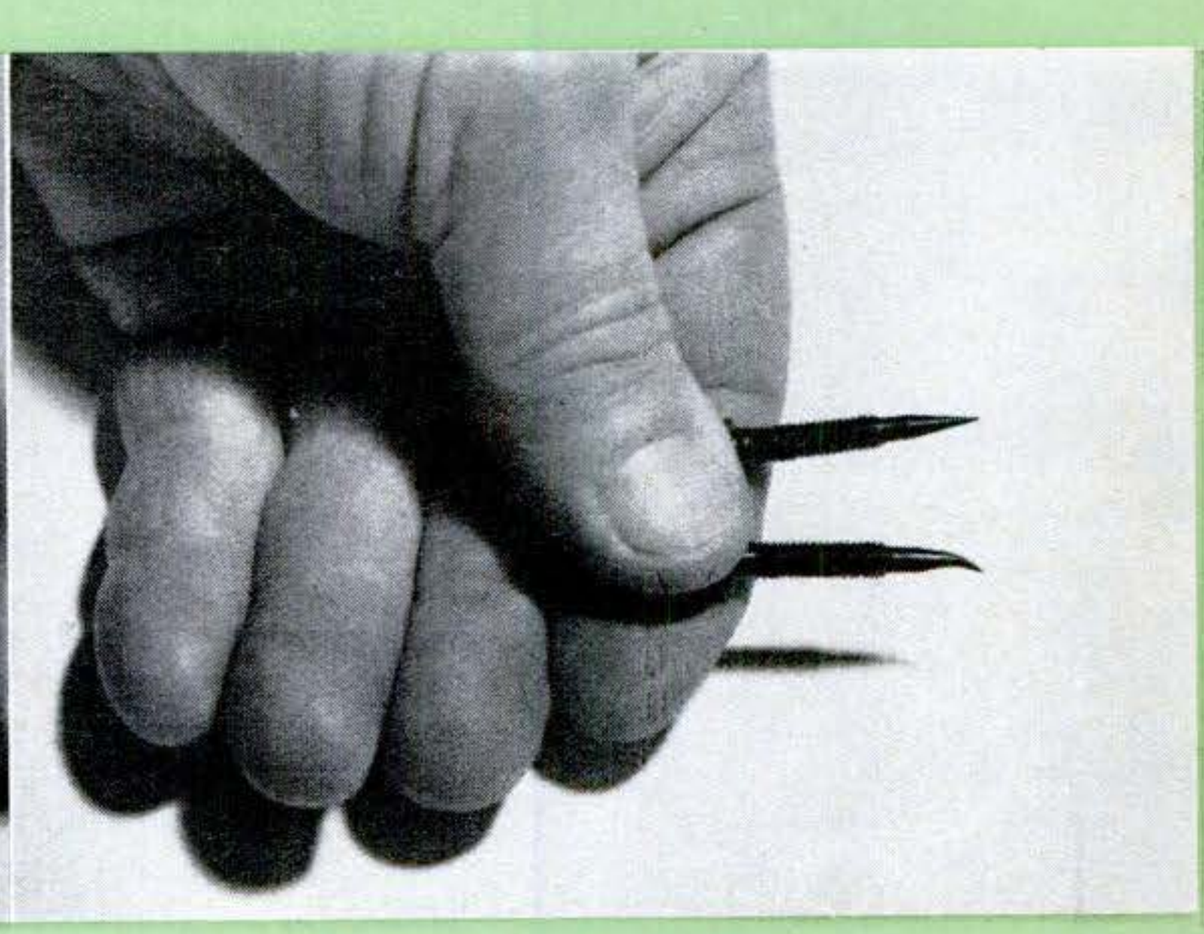
15,000—that's how many parts there are in the average full-size automobile. About 10 percent, or approximately 1,500 of those parts, move—every one of them a potential source of trouble. We hope our series of car quizzes starting in this issue will improve your ability to narrow down the possible candidates among all those parts when your car is ailing and, at the same time, increase your pleasure in the satisfying detective work involved in trouble-shooting. Future quizzes will cover many areas; among them—ignition, cranking, cooling, lubrication, valves, suspension, steering, power train, wheels, and brakes. Watch for the second in this series next month.

4 Prime candidate: a worn float-needle valve and seat, or a grain of dirt lodged in the valve seat. Clean and inspect these parts and replace them if necessary.

5 Check the air cleaner first. If it's restricted by dirt, it won't let enough air into the carb to permit thorough burning of the fuel/air mixture in the combustion chambers.

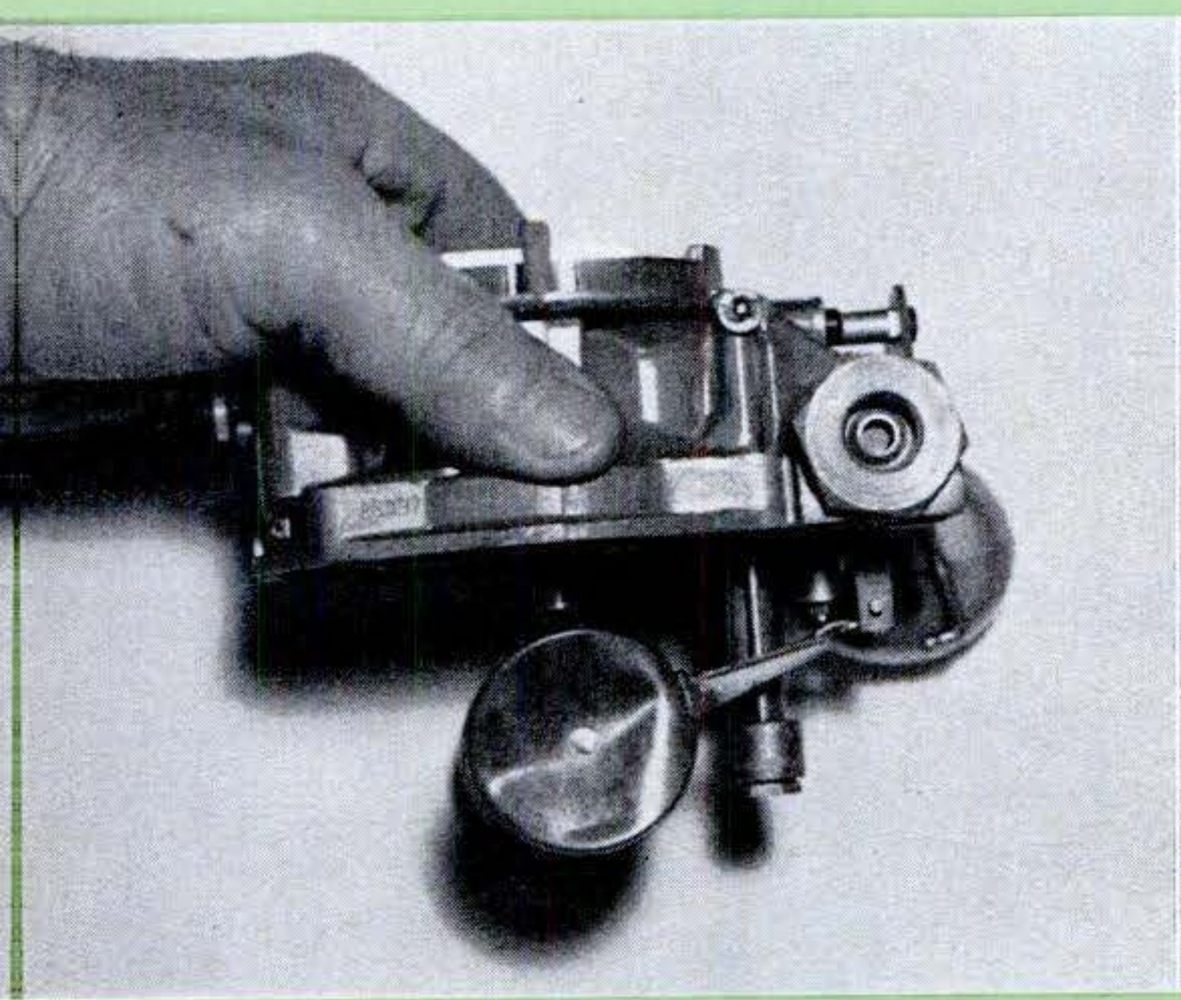
6 There's probably an obstruction in the fuel filter. Replace the filter. If it's a paper filter, be sure to soak it in gasoline for five minutes before you install it.

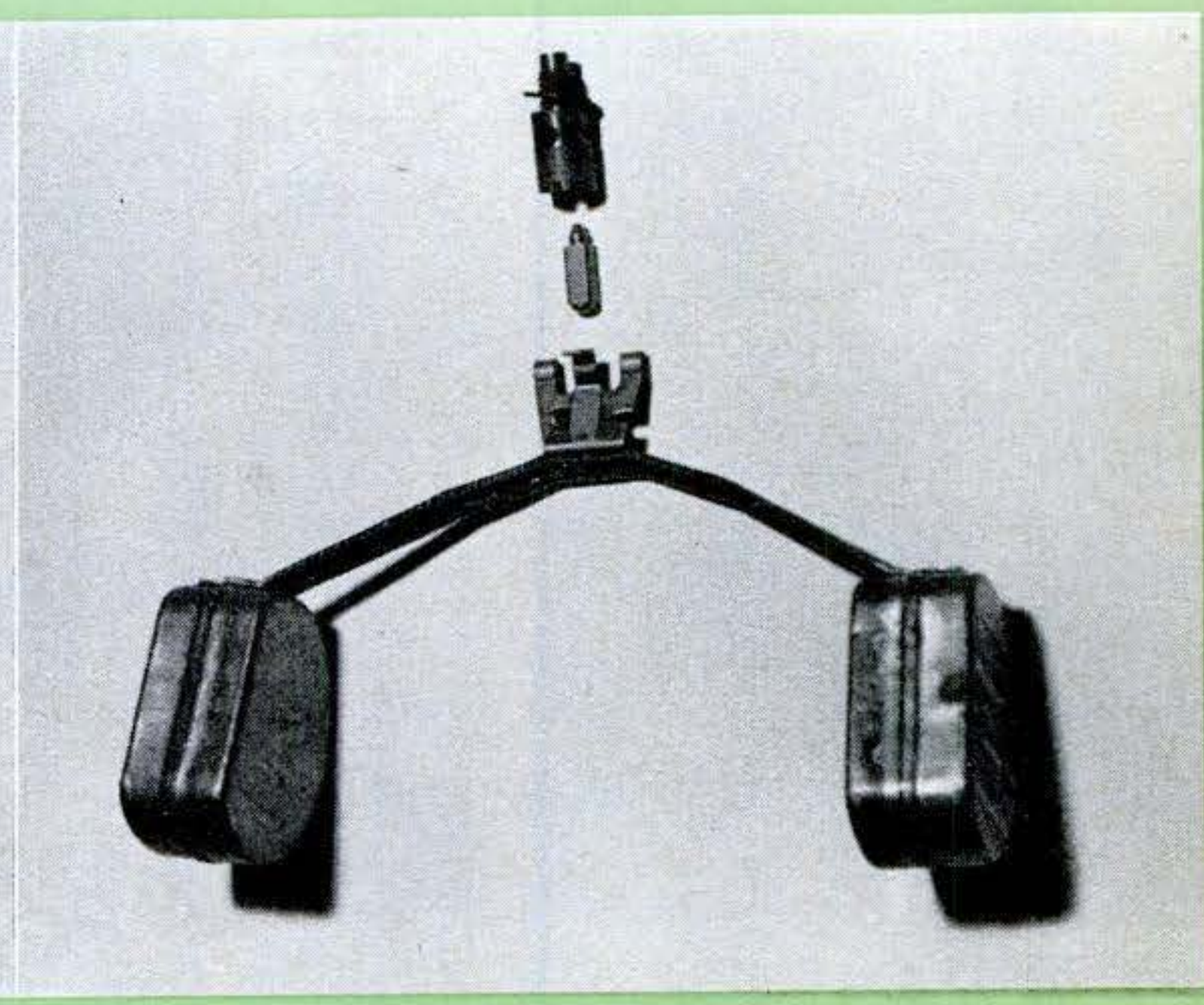




To overhaul a carburetor, dismantle everything except choke and throttle valves. Clean all parts (except plastic parts and choke diaphragm assembly) in solvent, then inspect. Use compressed air to blow out orifices.

When is an idle-mixture needle bad? When its point is blunted or bent. Needle at top, above, is good. To keep emissions within acceptable limits, use an accurate exhaust-gas analyzer when adjusting idle speed.





Float is revealed with bottom half of carburetor removed. Proper operation of sensitive float assembly is essential to good engine performance. A malfunctioning float can be the basic problem in flooding or leaking carb.

Suspect failure of a float-assembly part—needle-valve seat (at top of photo), needle-valve (at center), and float—when you smell gas fumes in the engine compartment. Service manual for your car will provide specs for float-assembly adjustment.

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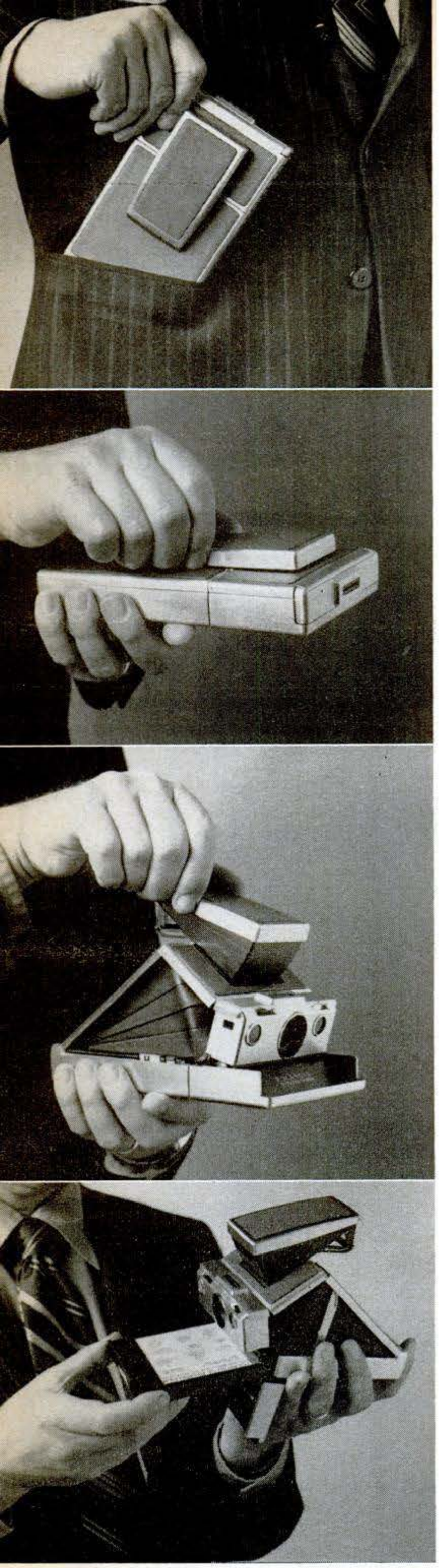


10 COLOR SHOTS IN 20 SECONDS!

Inside Story on the

Dr. Land's marvelous new invention is hard to believe—but it works

By ARTHUR FISHER
Group Editor, Science and Engineering

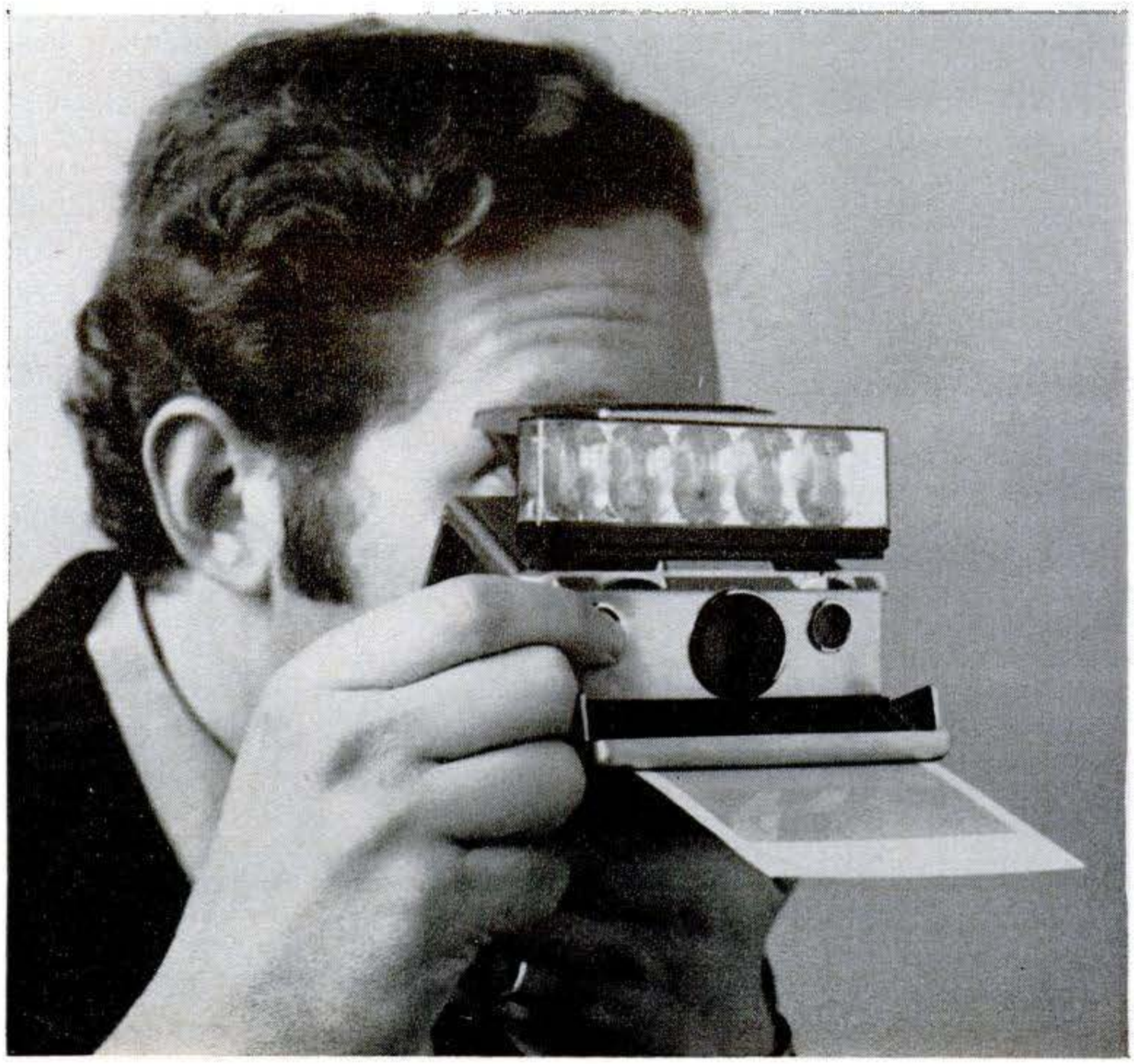
I've been astounding friends lately with an unbelievable new camera—the Polaroid SX-70.

I just walk over to one of them, pull the camera from my pocket, open it, look through a viewfinder, and push a small red button. There's an immediate click, a whirr and a whine, and within 1½ seconds a plastic card spits out from the front of the camera. It's a white rectangle with a 3⅛-inch, blue-green blank square on it.

I hand the card to my friend and tell him to watch it closely. In broad daylight, within seconds, like the invisible writing we remember from childhood, the first outlines of an image form. Then, magically, the turquoise field alters and colors appear, at first pale, then more and more intense, until, after a few moments, my flabbergasted friend is holding in his hand a full-color likeness of himself

Self-developing pictures. The print that's popped out of the camera is bone dry, perfectly clean, and so tough you can step on it or immerse it in water—even as it's changing before your eyes—without harm. There's nothing to peel off and discard; no caustic, messy chemical-laden scraps to avoid: It's a "garbage-free" system to delight any environmentalist. There's no need to fix the image chemically; there's nothing to mount—the image is already protected by a plastic coating, and the card *is* a mount. And because the film is automatically propelled through processing rollers that rupture a self-contained chemical pod, and then develops outside the camera by itself, there's nothing to pull, and nothing to time.

A pocketful of miracles. This film is certainly the most fantastic element in the SX-70 system, but the rest of the package is almost as hard to believe. Who ever heard of a folding single-lens reflex camera—with no prism, yet? Who ever heard of a camera that does everything except ask the subject to look at the birdie and



From pocket to print: Opening the SX-70 is a snap. One tug on viewfinder housing unfolds camera into shooting position. Pressing a latch drops front bed to allow film-pack loading (bottom). New 10-shot (five on a side) GE FlashBar plugs into top of camera (right). A push of the button takes picture, pops out print in 1.5 seconds.

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Pocket Polaroid SX-70 Camera

then hands you the picture on a platter? Who ever heard of a system that allows you to snap-shoot 10 full-color pictures and have the prints in less than 20 seconds?

The answer is that no one ever heard of such things until the formidable Edwin H. Land conceived, some 30 years ago, what he called "absolute one-step photography." His quest for that once-impossible dream came to fruition in the Polaroid SX-70 Land camera. It embodies an awesome constellation of technical triumphs in optics, dye chemistry, and micro-electronics, all distilled into a pocketful of miracles—perhaps the most fiendishly clever invention in the history of photography.

"Impossible"—but true. Like most people who witnessed the first demonstrations of the SX-70, I was very impressed, and said so [Dr. Land's "Impossible Dream," PS July '72]. Now that I've had a chance to use the $180 (list) camera, and have unraveled most of its secrets, I'm even more impressed.

You can judge the performance of

Continued

Where's Tony? Picture within a picture (left) tells film story. Print of author's son, reproduced actual size, shows him holding a print made seconds earlier. It is a turquoise-colored blank, but image will appear ghost-like in 30 seconds, keep on developing until virtually complete in five to 10 minutes. Gallery of SX-70 photos (above) demonstrates virtuoso performance of film.

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Like magic: Development of print starts when it is ejected from camera, continues even in bright light until full-color picture has formed. Sequence above shows how process looks at various intervals. Blue-green blank card at left is exposed film just out of camera. In minute or so, image becomes visible with colors beginning to emerge from turquoise background. Last two pictures are at five minutes and 10 minutes, respectively. Even after development seems complete, prints improve.

the SX-70 film (price: $6.90 per 10-shot pack) by the prints reproduced here (some mine, some Polaroid's). Colors are far superior to those of Polacolor, with better saturation and more accurate rendition. Just look at those reds! Flesh tones tend toward pink under certain circumstances, but this is usually not unflattering. (Magenta is a problem; it shifts toward orange.) There is remarkable detail in the shadows, and considerable exposure latitude; speed is about 150. These properties, combined with medium contrast, a resolution of about 40 lines, and the absence of visible grain, give the SX-70 prints an unusual—and pleasant—"soft-sharpness," an effect the printed page cannot do justice to. They also appear to have an unusual, gem-like depth and brilliance. Reason? The color image lies underneath several transparent layers of film, and is seen against a very bright layer of white pigment (more about the film chemistry later).

The only real problems I had came on a cold day, when I should have stuck the film in my shirt pocket to develop, but forgot. The result was underexposure and color shifts. The allowable development temperature range is considerably greater than Polacolor's 60-80 degrees, but when the temperature drops below 45 degrees or so the film should be kept warm by body heat. The optimum development temperature is 72 degrees. (Incidentally, the camera will operate from —20 to 120 degrees.)

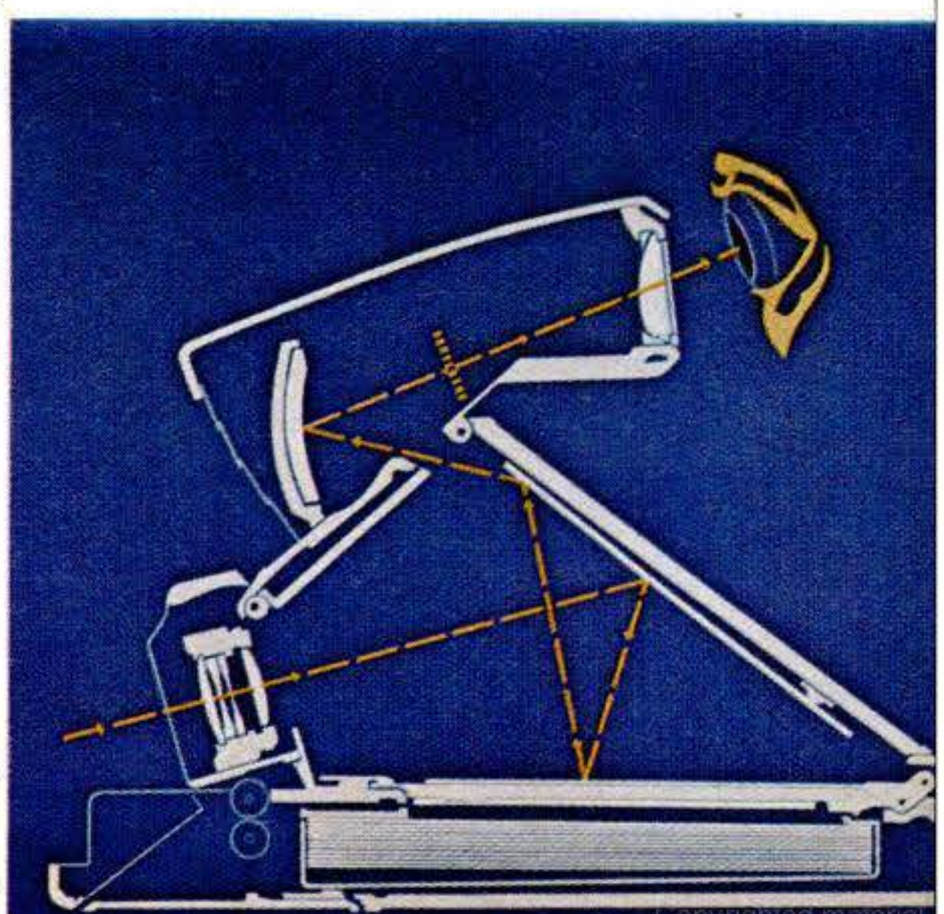
The new SX-70 film has one virtue that will become apparent only with time. It uses completely new, metallized dyes that are far more resistant to fading from ultraviolet exposure than Polacolor's. Indeed, says Dr. Land, they give "images that are completely stable as far as we know."

How does the SX-70 turn out these lustrous color images?

The camera body. Start with an empty camera in closed position. It's the size of a fat paperback novel, and thus pocketable. The case has top-grain leather wrapped around what looks like brushed chrome. The material—a new one—is actually glass-filled polysulfone plastic with three metals (copper, nickel, and chrome) bonded on. The combination gives high tensile strength, rigidity, and low weight—only 24 ounces for the whole camera.

It's all done with

Intricate innards of new camera are revealed by cutaway painting (left). An exposed film is emerging between processing rollers, propelled by a 12,000-rpm motor linked to a precision gear train. Film pack and battery are cut away to show printed circuits below. At front are the four-element lens, with shutter blades between the two rear elements; silicon photocell; lighten/darken control wheel; and shutter button. **In view-**



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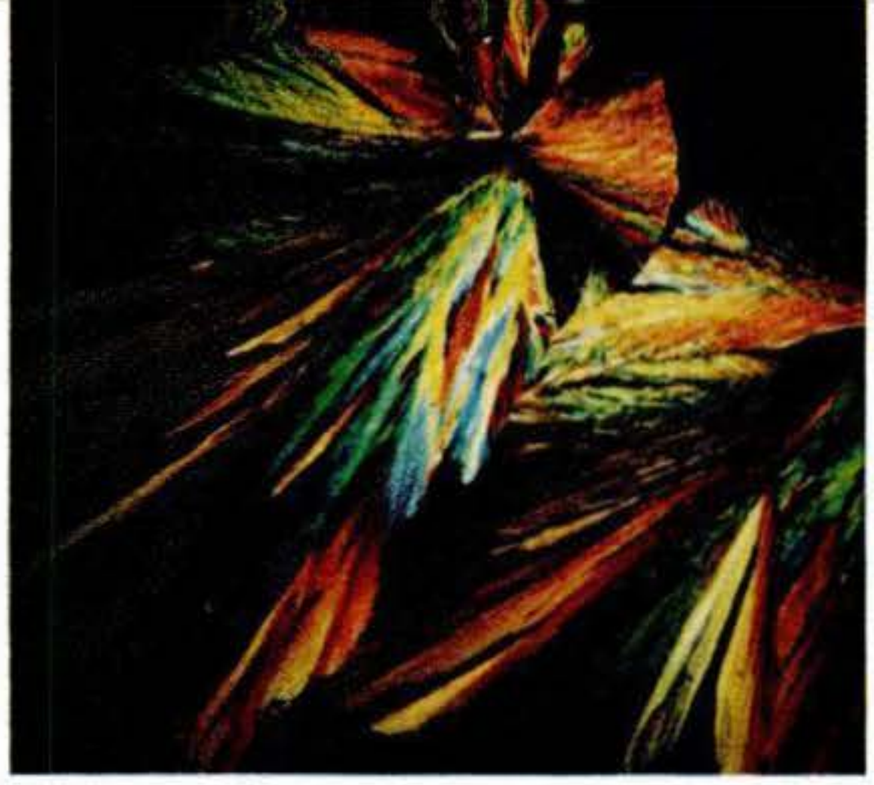
To open the SX-70, you pull up on the viewfinder housing, and the camera unfolds as pictured in the sequence shown on the first page of this story. To load, you press a latch that drops the front bed of the camera, insert a film pack of 10 film cards. When you flip the drop-front up again to close it, you're in for the first surprise: The protective cardboard cover of the film pack is ejected through the front of the camera, uncovering the first film for exposure. The power source: a unique, thin, six-volt battery contained in the film pack. You get a fresh one after every 10 shots.

You compose and focus by looking through the eyepiece in the viewfinder housing. You get exactly what you see—as in any other single-lens reflex.

Flash photos. If the lighting requires, you can plug a new flash unit into a socket atop the front panel of the SX-70. Called the FlashBar 10, the unit was designed specifically for the SX-70 by General Electric. It will fire five shots in a row on each side, 10 in all—and each flash is twice as powerful as an ordinary flashcube. The FlashBar connects to a memory circuit built into the camera, which eliminates misfires by skipping over bad or previously flashed bulbs and unerringly selects the next good bulb. Distance? The camera will make properly exposed flash pictures from five inches to 20 feet from the subject.

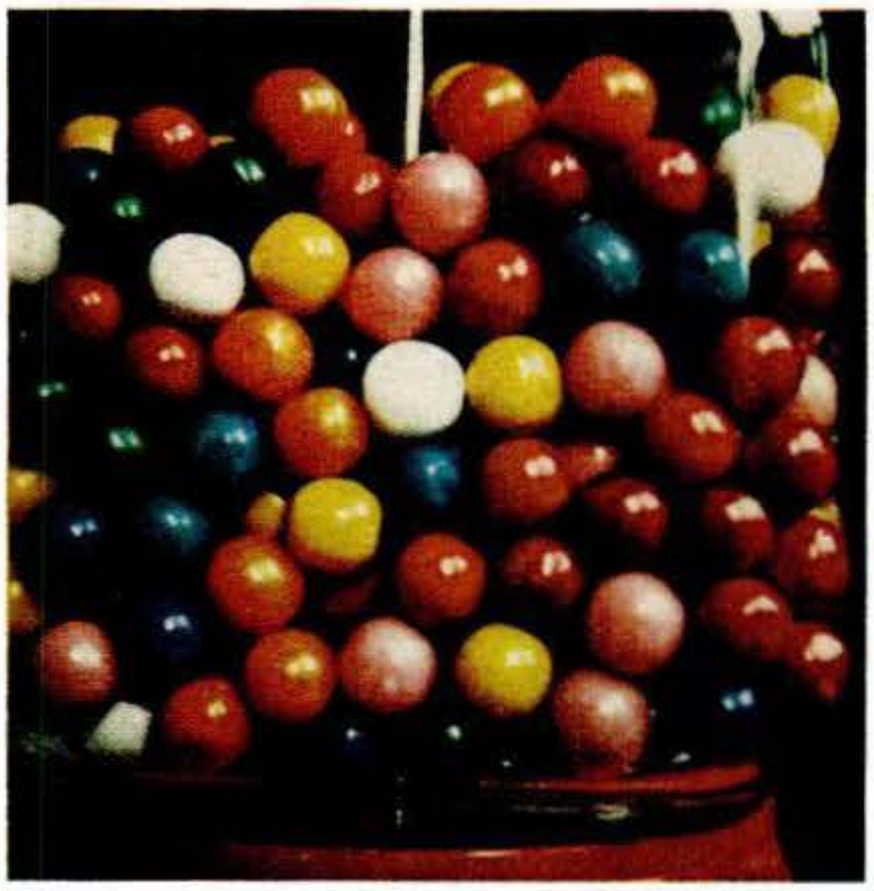
The optical system. But the optics inside the SX-70 are bizarrely unlike anything you've ever encountered in a

[Continued on page 114]

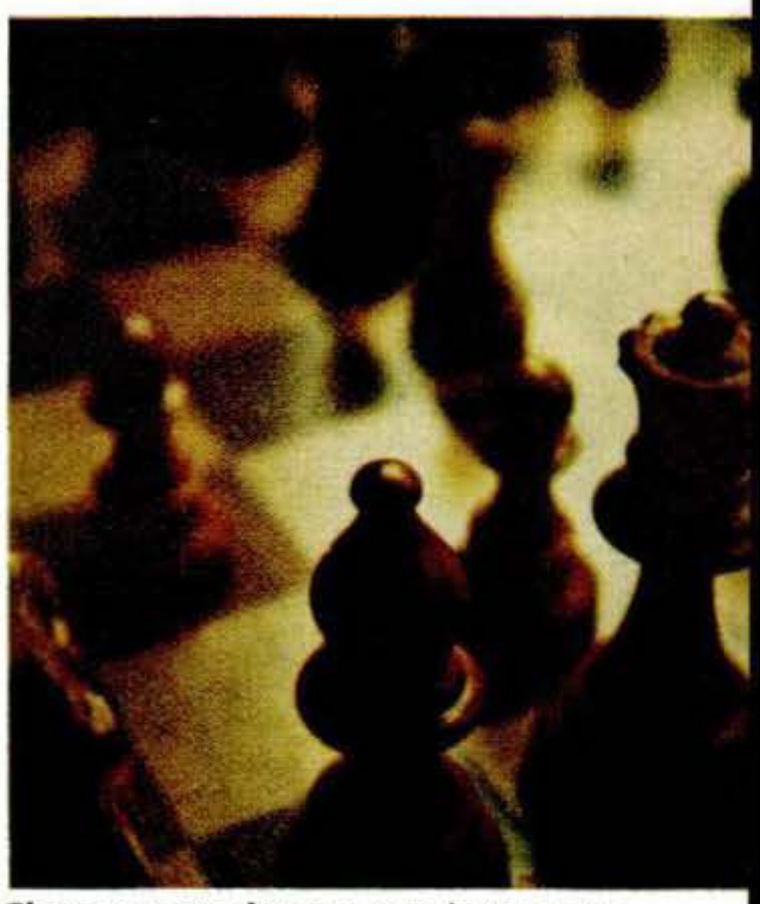


Photomicrograph: For proper exposure, light from subject is led to photocell via fiber optics probe.

Wide latitude of film makes it forgiving in tough photo situations, like this mirror mug shot with flash.



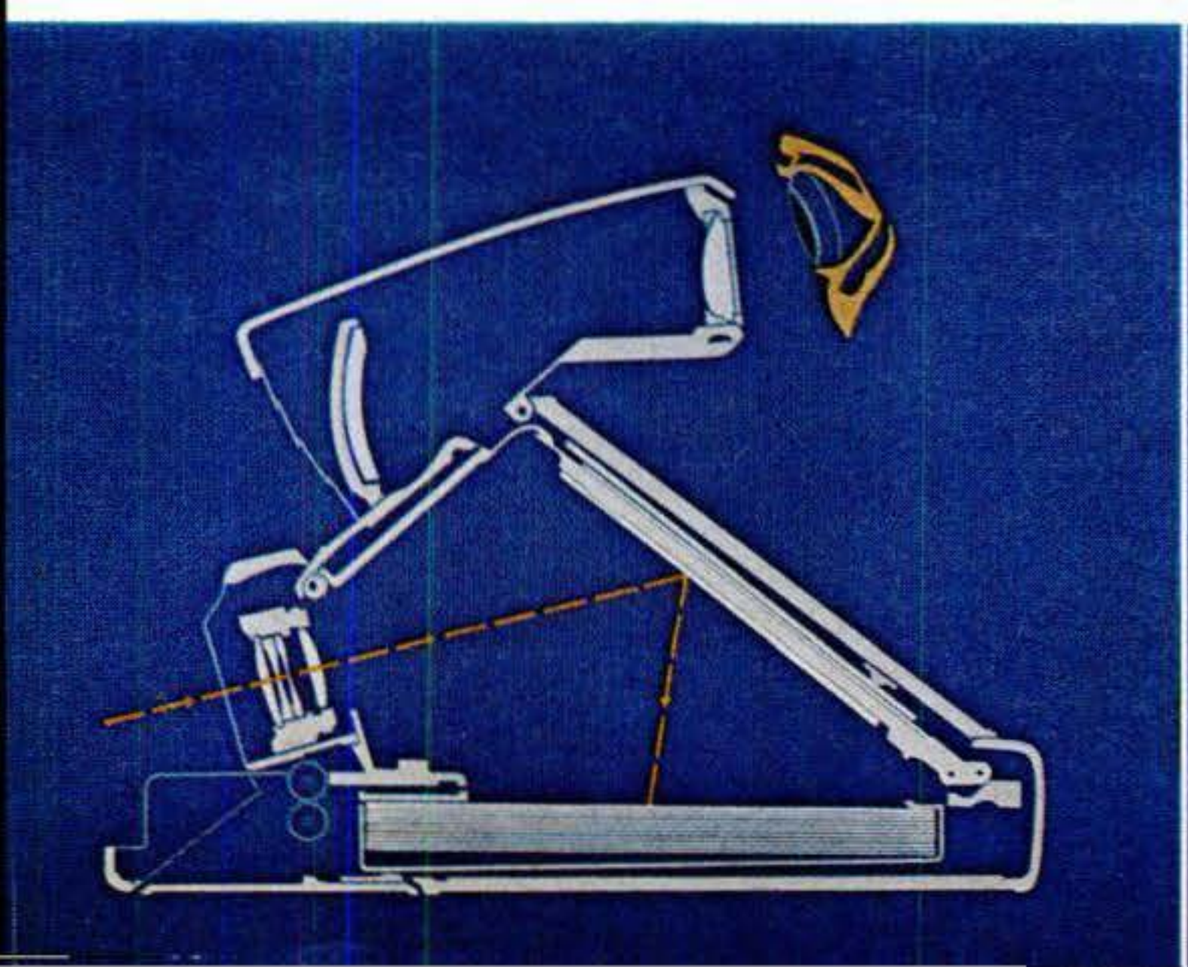
New film has excellent color saturation and rendition, adequate contrast, almost grainless structure.

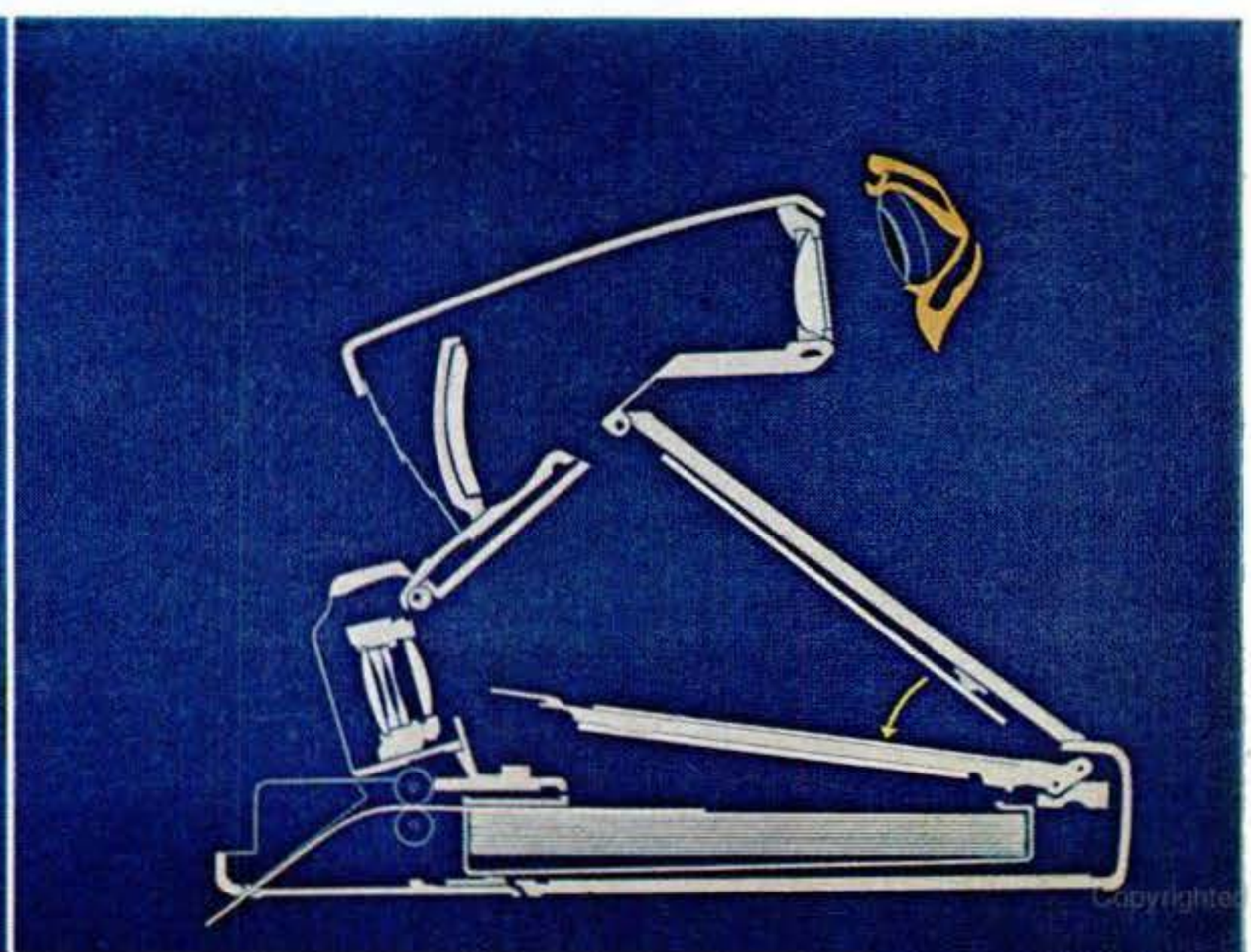


Close-up attachment can bring minimum focusing distance down to five inches, for life-size (1:1) images.

mirrors: Strange goings-on inside the Polaroid SX-70 camera

ing mode (below), light from subject enters camera through lens, reflects from fixed, slant mirror down to Fresnel surface of hinged carrier covering film pack. Fresnel acts as mirror and lens, bundles light into beam and bounces it back off top end of slant mirror out of camera through tiny hole Light hits viewfinder's concave aspheric mirror, which forms image in plane between mirror and eyepiece. **In taking, or exposure, mode** (below, center), hinged carrier flips up against slant back, uncovering film. Underside of carrier is a plane mirror, which fixed mirror replaces in light path. Light from lens reflects down from this mirror, exposes film. Flexible rubber flap attached to tip of hinged carrier seals off exit hole at top of camera to prevent light leaks. **In processing mode** (below, right), motor and gear train drive exposed film out of camera through small processing rollers, which rupture pod containing chemical reagent at front end of card-like print. Chemicals spread between bonded negative and positive layers inside film, begin the development process, which continues outside camera, in light millions of times stronger than original exposure. Meanwhile, hinged carrier drops down to cover film pack, and camera returns to its viewing mode.





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A fast game of knock hockey turns to the slower, more deliberate game of bumper pool at a flip of the table. Bumper-pool table is full-size, sturdy, and easy to level, even on a rippled floor, thanks to special adjustable jacks in the table legs.

Flip-Top Table: Two Games in One

It's a two-sided hit—a sure-fire center of action in any man's rec room

By JOHN CAPOTOSTO

Bumper pool or knock hockey—which is your piece of the action? You can take your choice with the flip of a table top.

This unique table sports a regulation-size bumper-pool table on one side and a satisfactory hockey table on the other. When you want a change of pace, simply flip the top over and a new game appears.

Sturdily built, the table features a simple but positive locking device that assures solid-as-a-rock rigidity—so important to a game of pool. The flip-top mechanism is so simple even a child can operate it.

The table is built of pine, both ¾" and 1⅛" stock. The bed is of U.S. Plywood's Novoply, an excellent material because of its smooth surface and, more important, its warp resistance. The bed size is 32" by 48", which is one third the size of a standard 4'-by-8' sheet. Most lumber dealers will sell a third of a sheet, but a full sheet costs less than $10. Perhaps you'll want to make a couple of extra tables, for they make excellent gifts.

Build apron first. Use 1-by-8 common pine, which actually measures ¾" by 7½". If you choose your lumber carefully, you can eliminate most knots. Rip the boards 7¼" wide, make the ball-return cutouts and bushing holes, then assemble with glue and nails. Use galvanized finishing nails for tightness if you can.

Before nailing, size the end grain of the end pieces with white glue thinned with water. Brush on and allow to air-dry about five minutes. Apply more glue full strength, then join the sections. For accuracy, temporarily nail a couple of diagonals to the frame as the glue sets.

Making the legs. Use 5/4 stock (5/4 stock measures 1⅛"). Again, choose the lumber carefully to avoid knots. The table shown was made of common lumber, yet no knots show. Location of the stretcher is important. Improperly positioned, it may interfere with tilting the table. Best way to handle this is to make a kraft-paper pattern of the leg including the cutout for the stretcher (the 1⅛"-by-5½" rectangle).

Trace the cutout onto the board; then, when assembling, you can use the traced cutout to align the stretcher on the legs. To keep the legs from moving during assembly, drive a couple of nails into them. Then you can drill the pilots accurately at your convenience.

To drill the holes for the leveling jacks into the bottom of the legs, use

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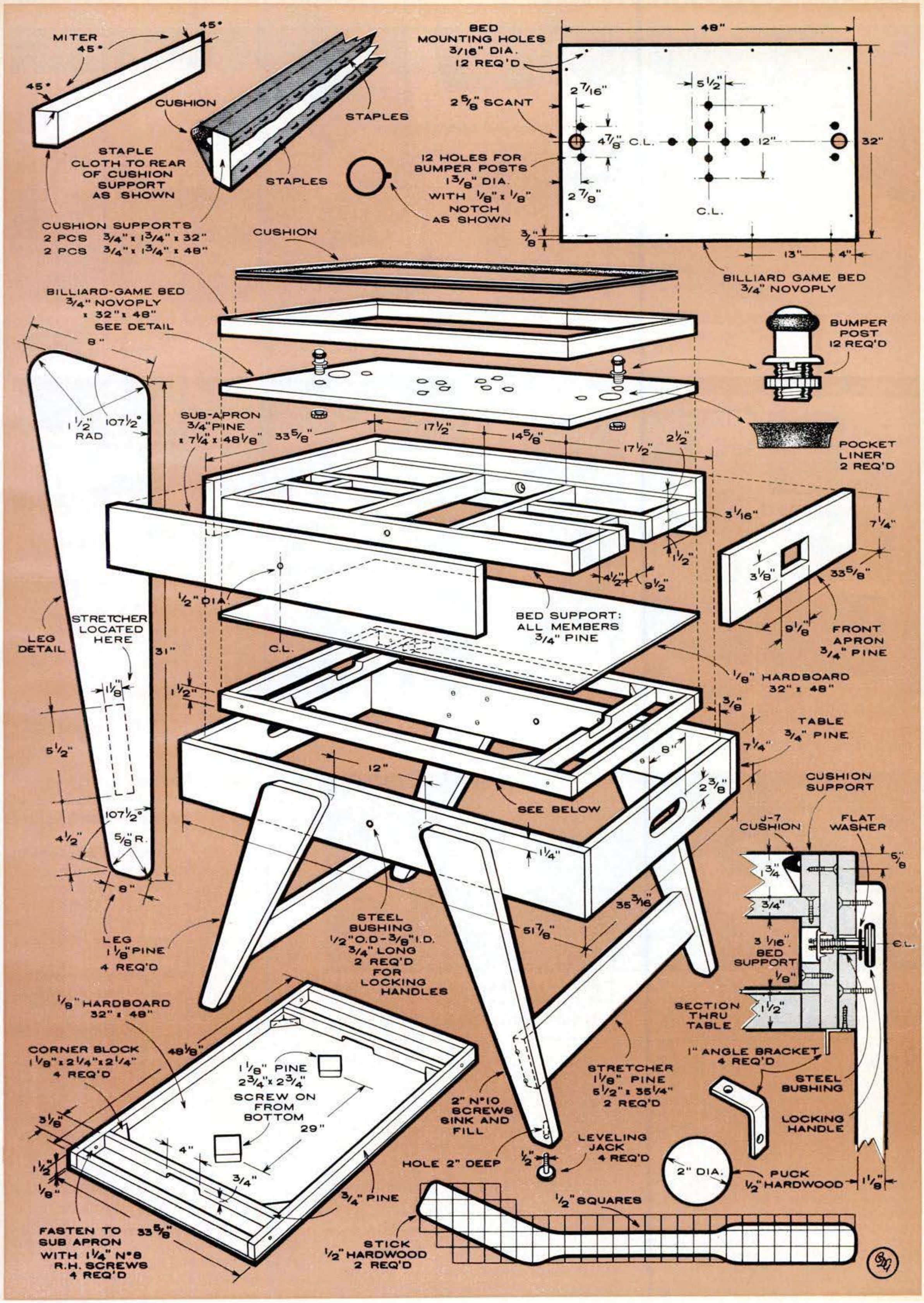

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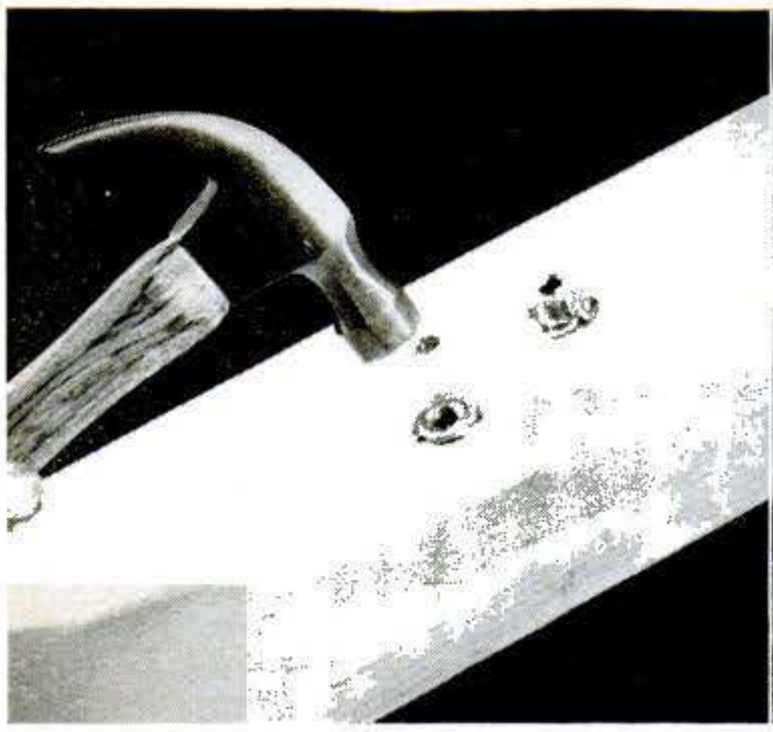
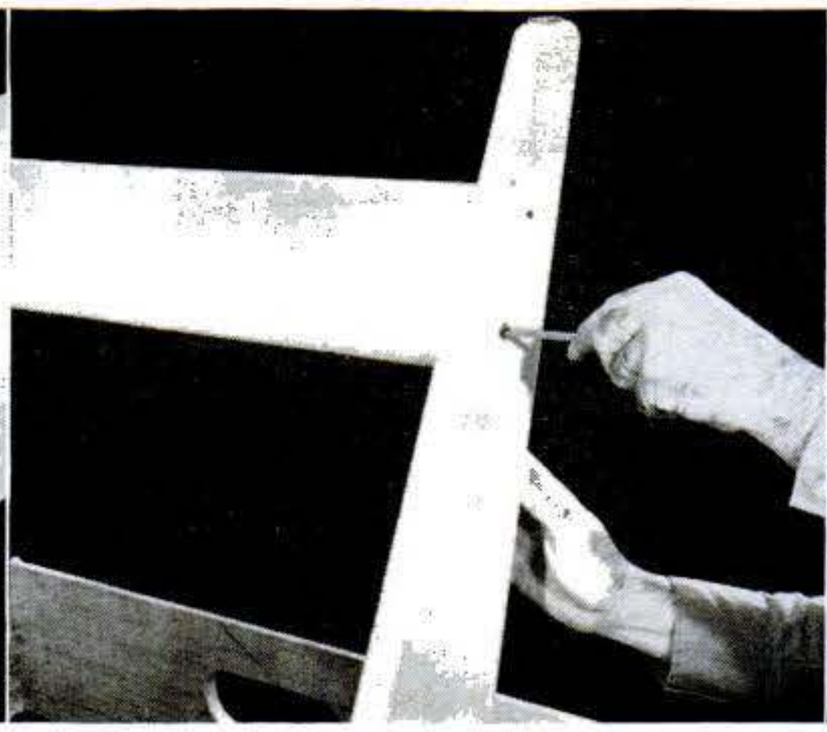
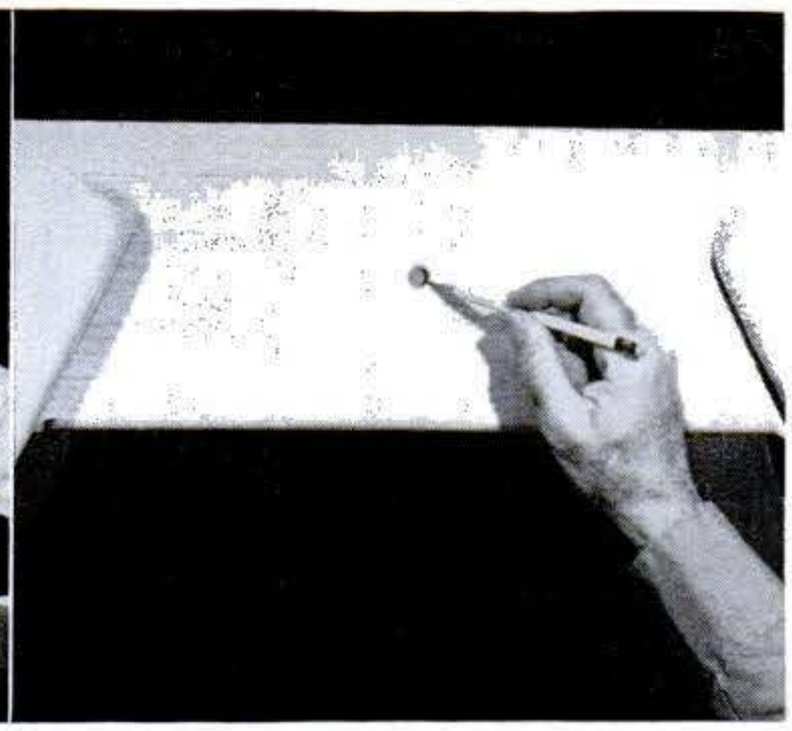


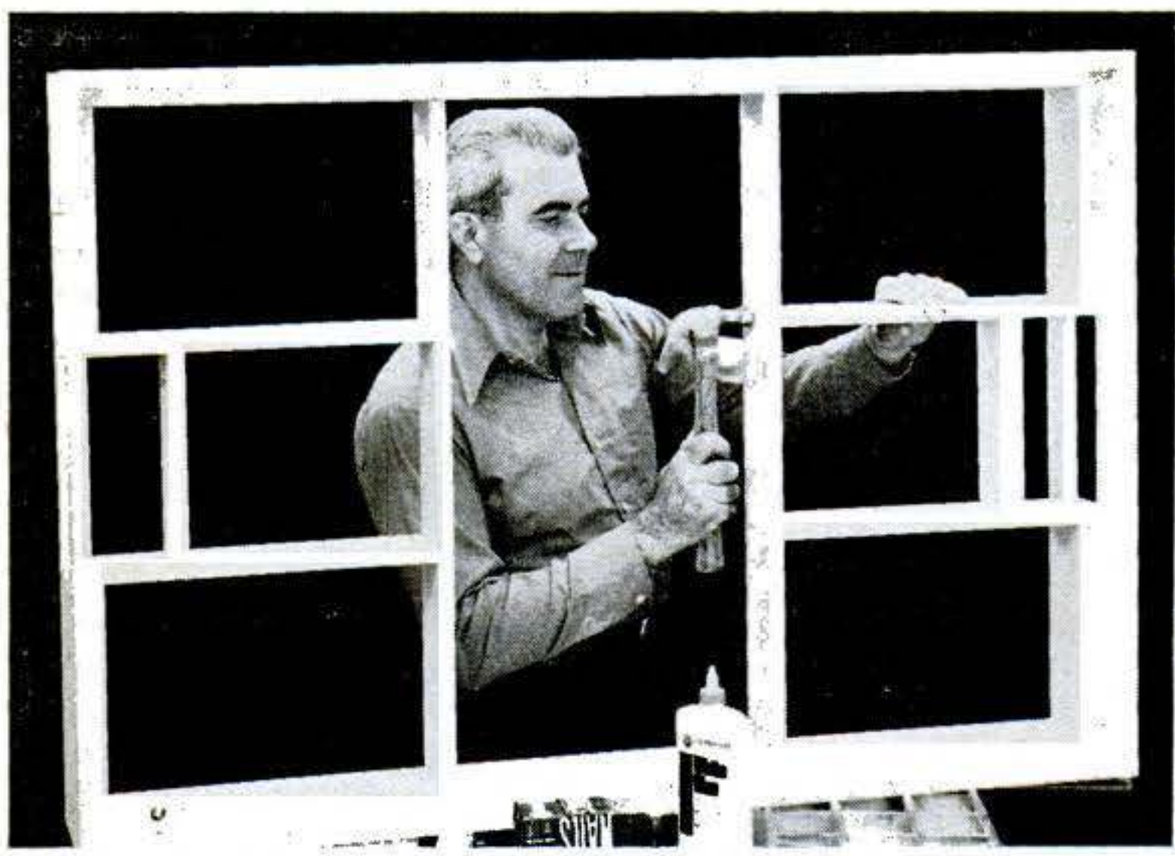
Heavy-duty T nuts support a good portion of the table's weight. Drill their mounting holes through sub-apron and drive in place.



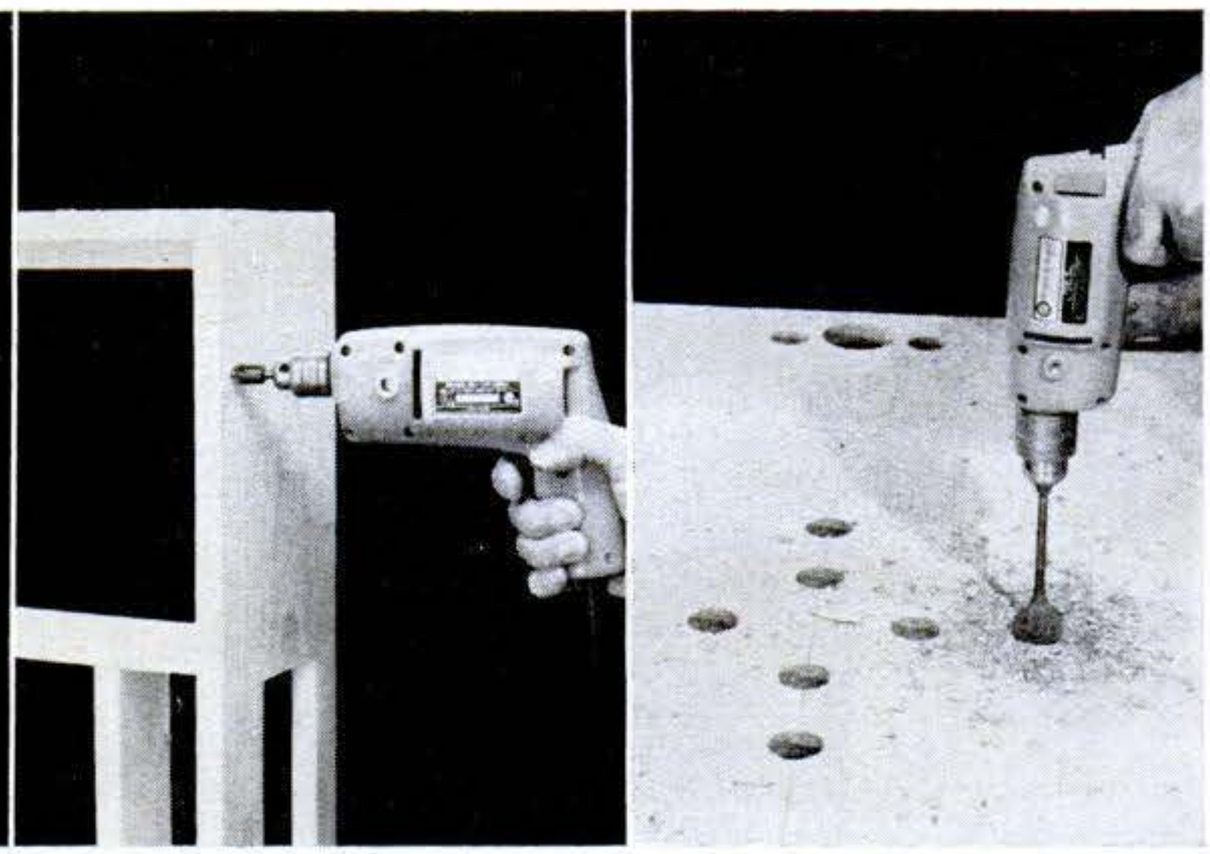
Rigidity required for a good game of pool is added to legs by stretchers. Glue and screw them in place—don't use nails here.



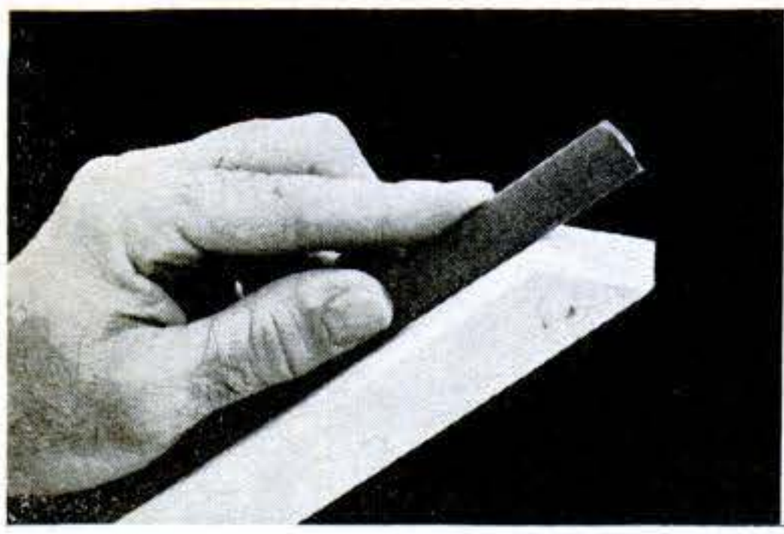
A bushing lines the hole in apron through which the locking bolt passes. Bolt also serves as the pivot point for table top.



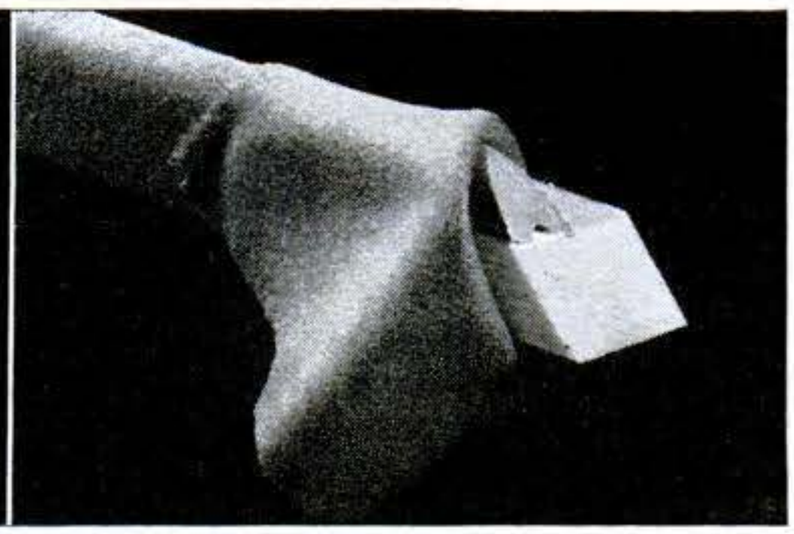
Sub-apron goes together with glue, screws, and nails. Use the screws to fasten the four main frame pieces and the two cross braces. You can get by with nails at other joints.



Cushion-support screws must be left accessible (left). Use flat-heads, and countersink them just below the surface. Drill bumper-post holes with a spade bit (above right).



Cement cushion rubber to support with the end overhanging slightly. Then trim to proper length and miter with a sharp knife.



Cushion cloth is stapled to backs of supports except at ends, where it is trimmed with a razor blade and cemented in place.

How to play bumper pool

Set-up: Five red balls (one spotted white); five white balls (one spotted red). When you order balls or table parts from Armor you'll receive a diagram for lining up balls at start of game.

Game: Opponents each choose a set of balls. To start, opponents simultaneously shoot at their spotted balls, each trying to bank his off cushion to his right into opponent's goal. If a player pockets his spotted ball, he shoots again—this time at a ball to his left. He continues shooting as long as he pockets a ball in one shot. If neither pockets a ball on his first play, the one nearest to opponent's goal shoots first. First to pocket five balls wins.

Penalties: You must not shoot at opponent's balls. Pocket an opponent's ball and it counts for him. Pocket an *unspotted* ball first and your opponent pockets *two* of his own by hand. If a ball leaves table, place it in center of bumpers and proceed.

How to play knock hockey

Object: To knock the puck into the opponent's goal. You may score goals by direct shots or by a carom played against the side or corner banks of the hockey table. If you knock puck off table you lose one point. To win you must score seven goals

a ½" drill, and be sure to drill square and straight, and perpendicular to the floor—not at the angle at which the leg is mounted.

To simplify assembling the legs to the apron, clamp a 1¼"-wide cleat across the top of the apron to serve as a gauge for the leg tops. Drill pilots and screw them inside through the apron into the legs, using glue and 1¼" screws.

Sub-apron. This is a frame similar to the apron but made with clearance so it will swing freely on its pivot. Clearance of ⅜" is allowed at the ends, 1/32" at the sides. Cut and install the bed support to the inside of the sub-apron, using a 2½" gauge block to position the support. Tack the support in place with brads, then screw permanently after drilling pilots and applying glue. You can toe-nail the two cross members, or you may prefer to nail from outside the support. If so, nail the long side pieces to the cross members, then install the assembly as a unit. Add the ball-box ends and sides.

Cushions. The cushion supports

[Continued on page 127]

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PS EXTRA: TAKE-OUT GUIDE

Another in our home-appliance series, this article may be removed for loose-leaf binding. Press magazine flat on a table, run thumb firmly along center fold, pull out both sheets gently. Repeat at continued page for all of article.

How to Install and Maintain a Humidifier

Better get one now if the air in your home is dry. But first, make sure the house has a vapor barrier

By EVAN POWELL

At this season of the year, a house may develop "dry-air blues." Cracks widen in the woodwork. Chairs and other pieces of furniture become wobbly. The membranes within your nose sense the dry atmosphere. And you may find yourself turning up the furnace thermostat to stay comfortably warm.

A humidifier is the usual cure for these ailments. If your home already has one, make sure right now that it's functioning effectively. If you don't have a humidifier, better buy one at once. What you'd save in fuel during the rest of the season could go a long way toward paying for it.

Your choices. In buying a humidifier, you can choose a self-contained unit (some look like a piece of furniture) or an accessory unit that goes into or on the plenum or duct of a warm-air system.

A humidifier puts water into the air in two ways. In the evaporative type, a belt or drum carries water from a fan. (A heating element within the humidifier may heat the air to carry more moisture.) The atomizing type, on the other hand, uses a nozzle or pump, to project tiny droplets of water into the air.

Choose a humidifier with a capacity to suit your home. In atomizing types, the size of the nozzle or pump is the major capacity factor. In evaporative types, it's the amount of air, its temperature, and the area of wetted surface presented by the evaporative belt or drum. Ask your dealer to guide you in this.

Before you buy a humidifier. Make sure there's a vapor barrier on the side of the insulation facing the inside of your home. Houses built since 1950 commonly have a barrier. Unless yours does, the latest, and best, advice is: Don't install a humidifier; moisture you add to the air will pass through the insulation, condense on the cold inner surface of the outer wall and cause rot within the wall.

Check your water supply, too. If the water has a high mineral content, choose an evaporative humidifier. The moisture evaporated into your home will then be free of minerals, and many new models have mineral-flushing systems that lessen need for frequent cleaning. If the mineral content is low (less than eight grains of hardness), consider an atomizing-type humidifier. These have tremendous capacity and generally require less maintenance.

These are the main factors you should consider in choosing a humidifier. There are others. For a discussion of them, see "More Comfort for Your Heating Dollar" [PS, Sept.'72].

Installing a humidifier. In a warm-air heating system, it's an easy Saturday project if you look over the job beforehand and line up your materials. There are four basic steps.

First, you connect the humidifier to the warm-air plenum (the large box or chamber attached to the furnace from which the warm-air supply ducts exit). Second, you connect the humidifier to the water line. Third, you connect the humidifier to the humidistat, and fourth, you connect the humidifier to the power supply.

Continued

Some of your choices in selecting a humidifier are indicated in these photos. Where you will install it depends on which you choose. The console type (top) can go anywhere in living area. Its reservoir can be filled by hand, or you can run copper tubing to water line and let float valve control flow. You can locate another evaporative type (center) on the ducting of a warm-air system. At bottom is through-wall atomizing type that projects droplets of water into air where they quickly evaporate. You can locate it in closet. Use it in soft-water areas. A dealer can offer other choices.

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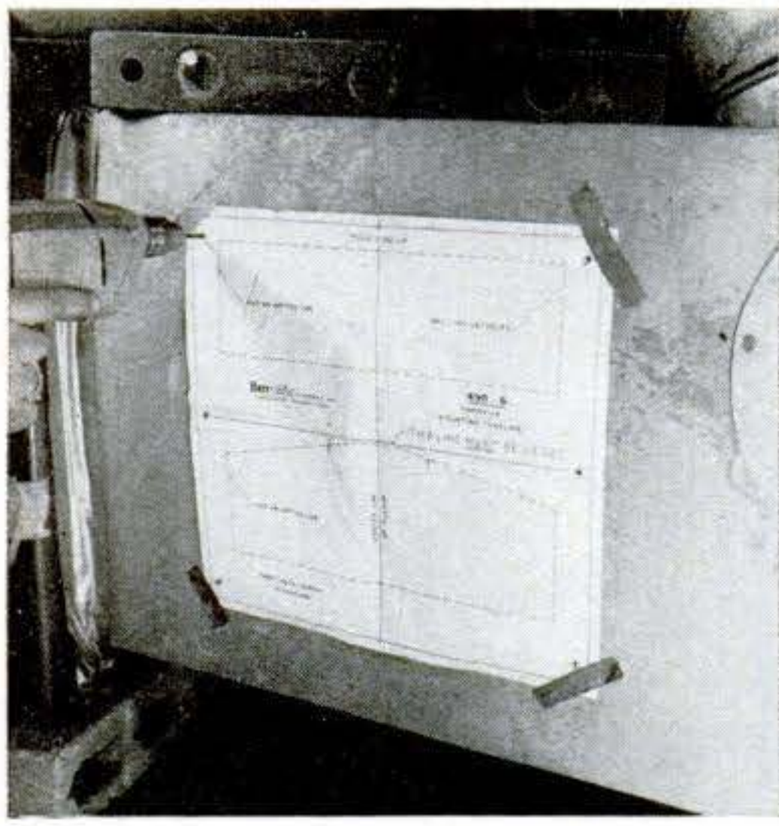
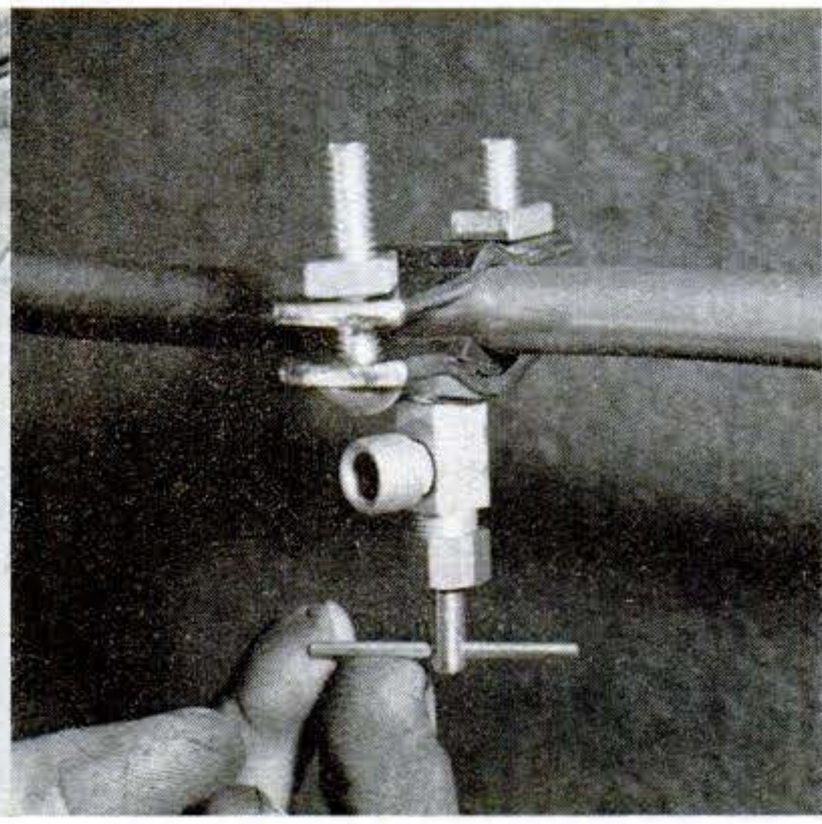
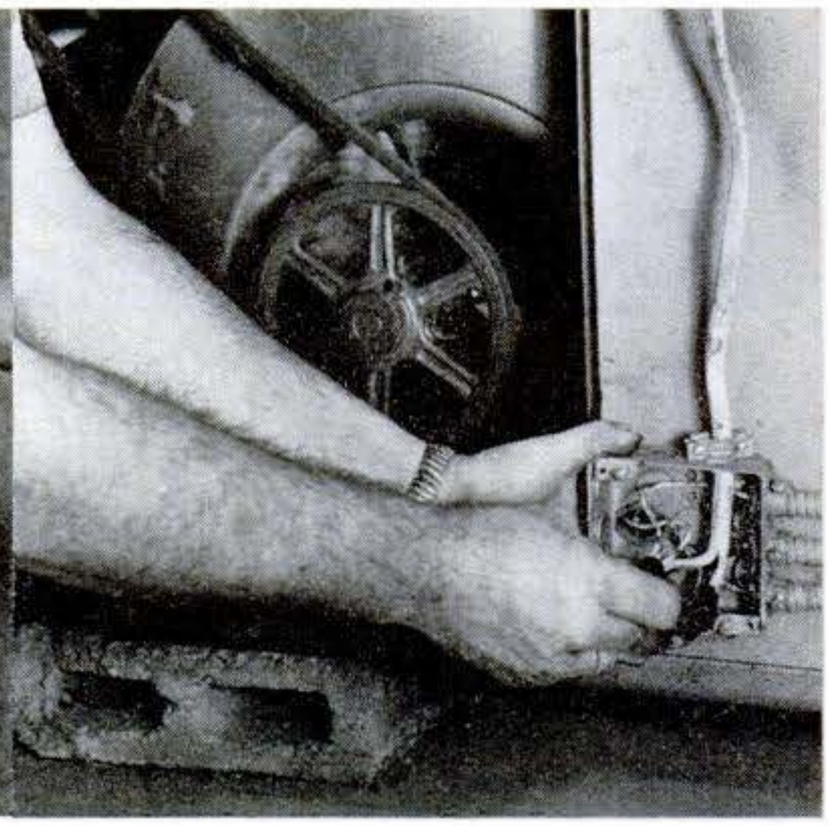
Some of the important steps to keep in mind in installing a humidifier on



Place evaporative unit so it's level on supply plenum of warm-air furnace—a must. Template helps you do this and serves as guide in cutting opening and drilling holes for mounting humidifier body.

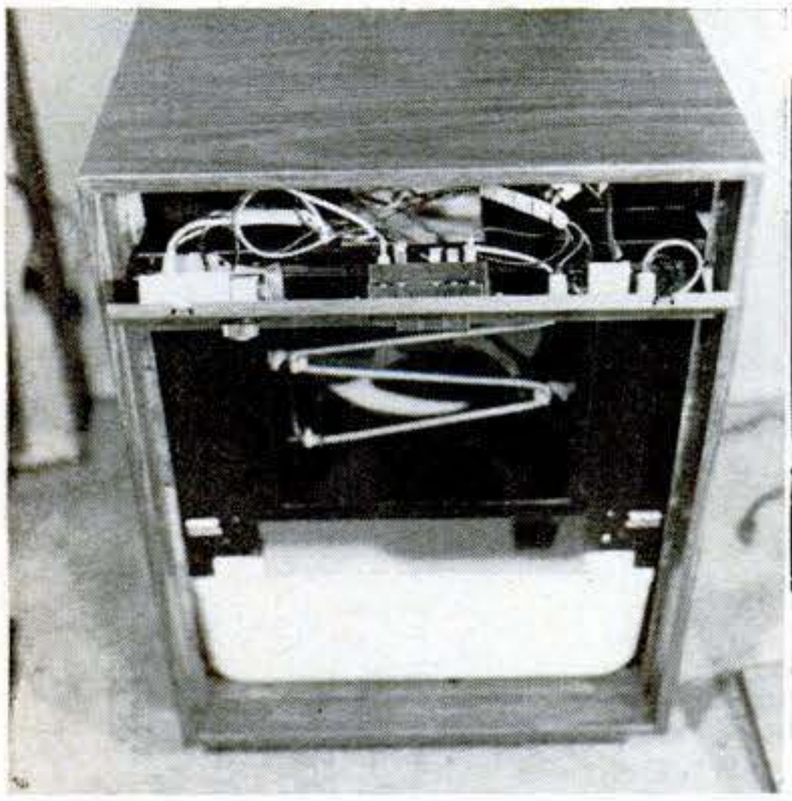


Locate a cold-water line and install the saddle valve. Self-piercing type shown makes its own hole when threaded shaft is turned down. If you must drill hole, use hand drill (not electric) for safety.

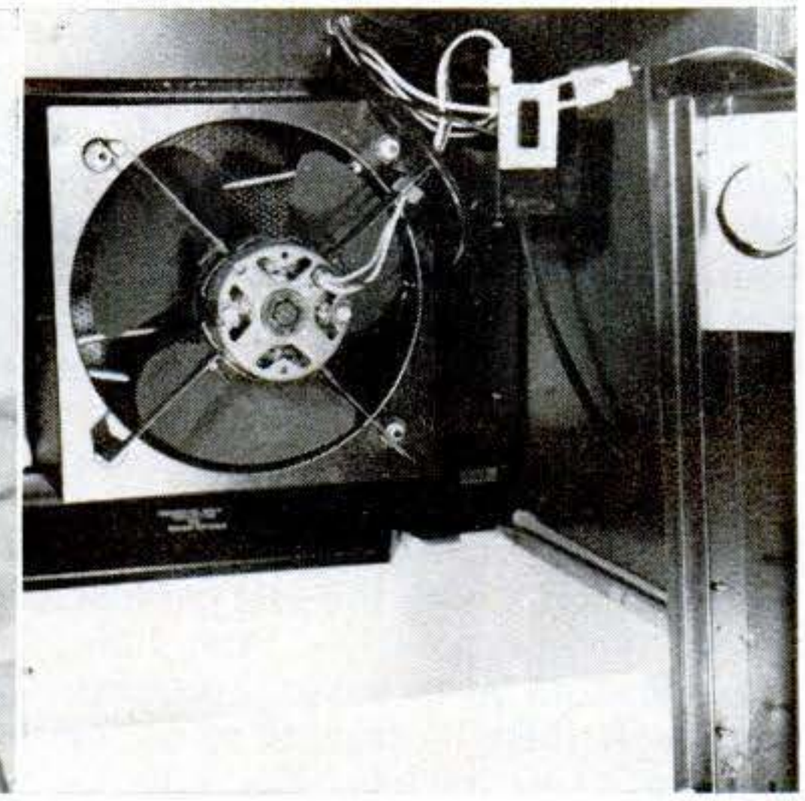


Wire up the humidifier by locating junction box or fan switch and making connections to leads that energize furnace blower motor, following wiring diagram with your instructions. Also hook up the humidifier-control

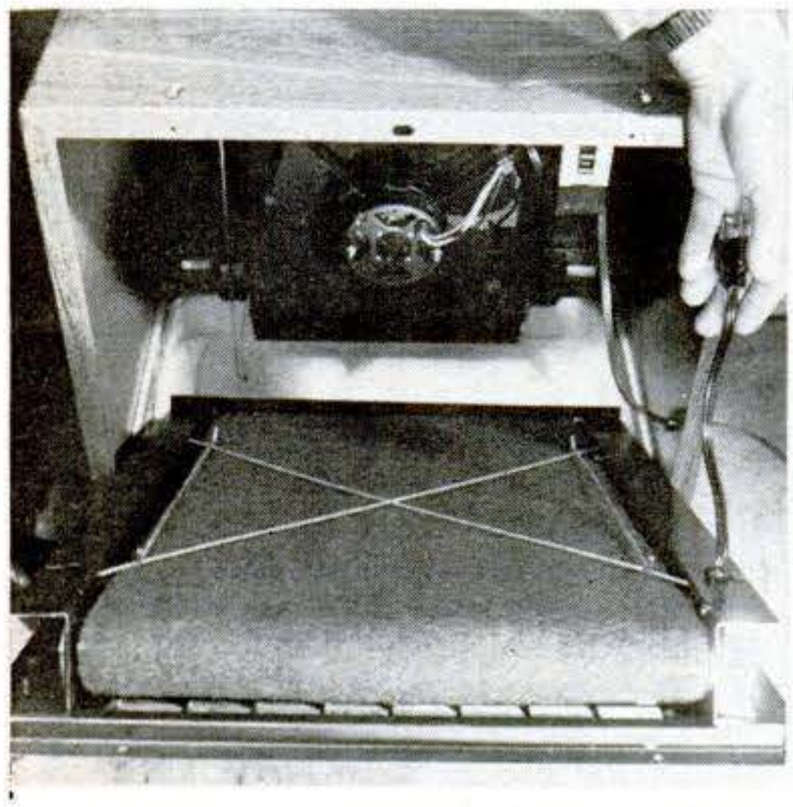
Service points to check in a console humidifier



Removal of front grille and panel allows testing and servicing of many parts of this model. Notice that the air-heating element is visible in the lower opening.



Rear view of this Herrmidifier model indicates how you can service fan motor, media track, and motor. Float rod into tank attaches to water-level indicator.



Evaporator belt (also called the media) and its track are easily removed from the rear after panel is removed. Plug (in hand) allows quick disconnect of unit.

Belt can be removed for cleaning in manufacturer's solution or white vinegar and water mixed half and half. Rinse belt well and drain. Handle carefully when dry.

The ¼-inch copper tubing for connecting to a water line may be supplied with the humidifier. If it is, make sure there's enough to reach the water line. If it's not supplied, measure the distance between the line and plenum. Allow a few extra feet so the humidifier may be removed for servicing and cleaning. Also buy enough wiring to reach the blower motor and fan switch on the furnace or plan to call in an electrician to make the connections.

Tools needed for a typical humidifier installation usually include a pair of small tin snips and a small hand drill (not an electric drill).

The humidistat. It's sometimes necessary to adjust the humidity to outside temperature conditions. Experts agree that 40 to 50 percent relative humidity in a home is ideal under normal conditions, but on extremely cold nights you may wish to lower this to reduce condensation on windows.

A good rule of thumb: Determine the lowest temperature expected, add 15, and set the relative humidity at this figure. For instance, if the lowest temperature expected during the night is 10 degrees, 25-percent relative humidity may be sufficient.

Your humidistat may be located in the living area or on the return plenum or air duct. A different type of humidistat is required for each. If you opt for the living area, be sure you locate the humidistat away from such sources of moisture as kitchen sinks, dishwashers, etc. Aim for a spot where it can sense an average humidity for most areas of your home. When located in the return air plenum or duct leading to the furnace, the humidistat will usually give a fair sample of the average humidity.

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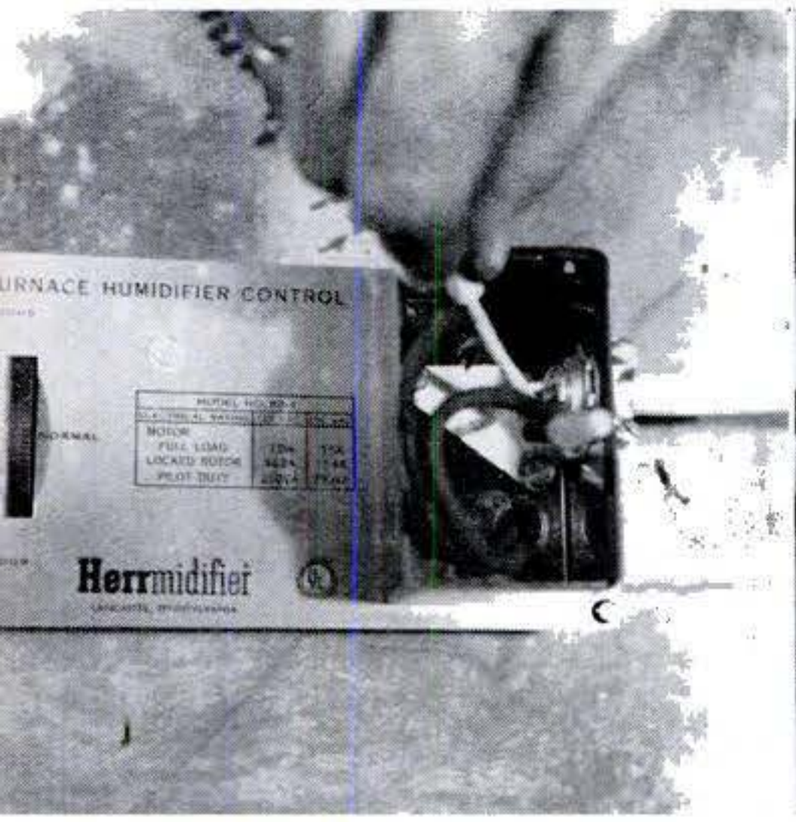
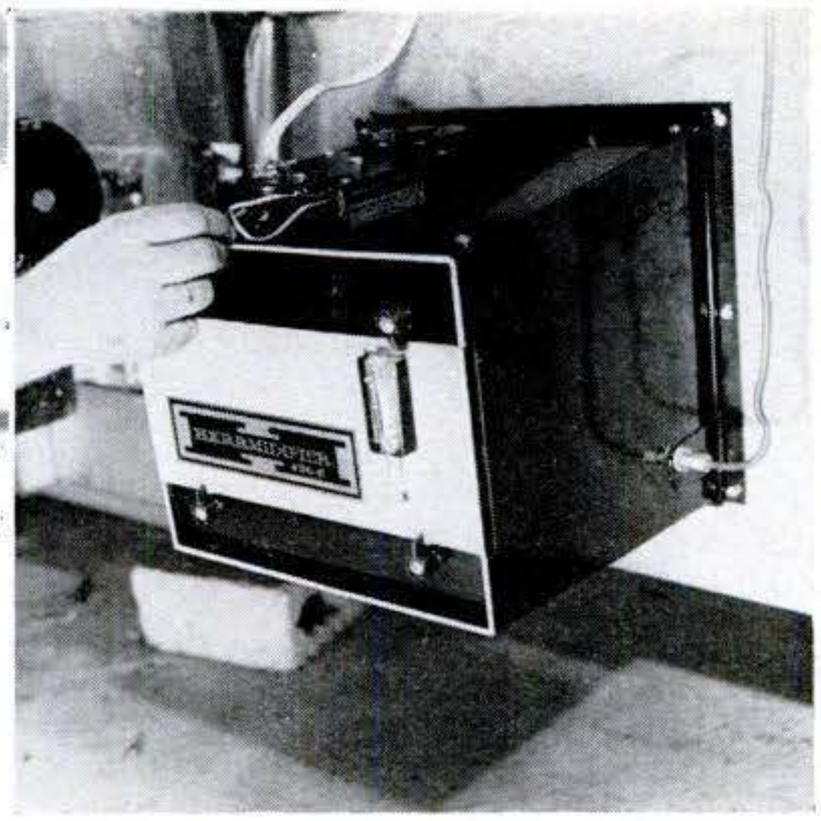
the duct of a warm-air system





unit. If you have central air conditioning, consult instructions that came with furnace. On some, a relay is needed to prevent damage to motor windings. If you have any doubts, call an electrician.

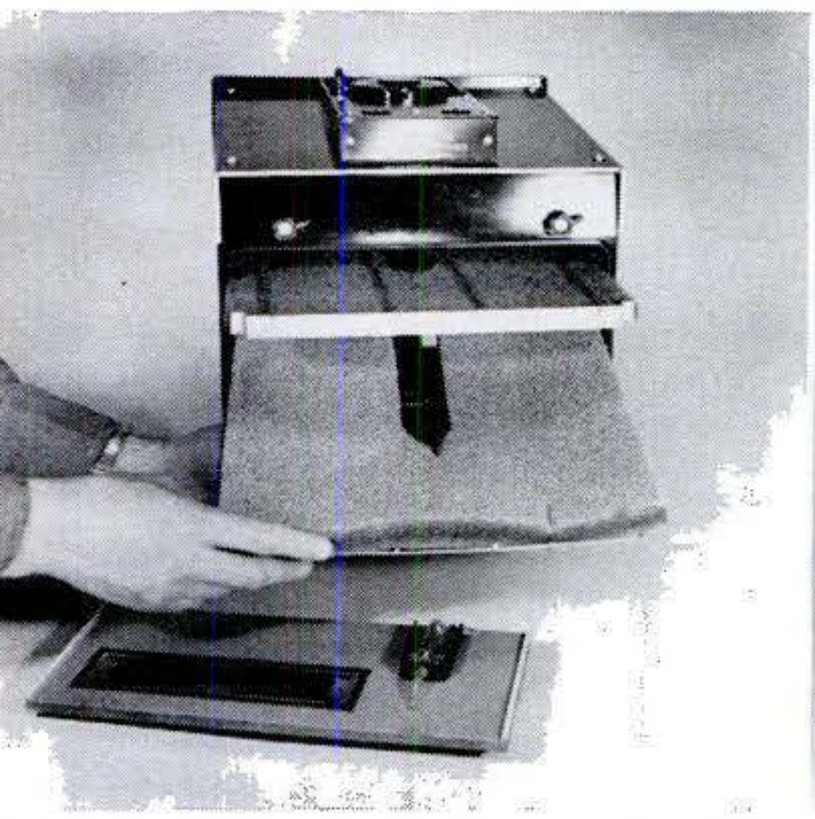
With connections made, turn furnace on and adjust controls. Check that humidifier turns off when fan does. If flushing system is used, run bleed-off to a floor drain (not outside; it could freeze).

It's easiest to install a humidistat on the plenum; but it does make it necessary to go to the basement or crawl space to make adjustments.

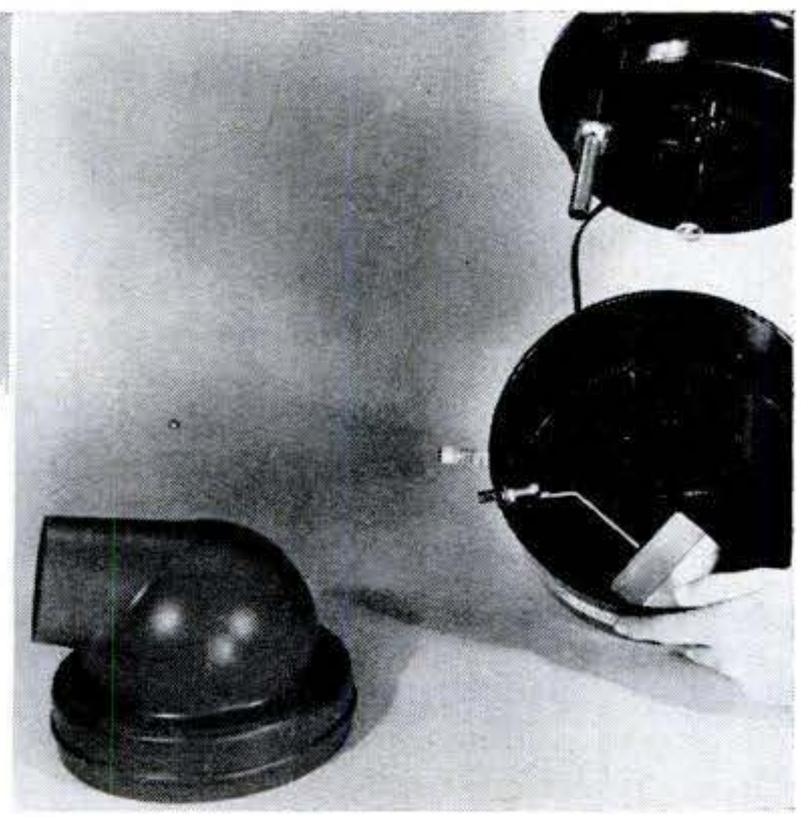
Servicing a humidifier. The service needs may depend upon water conditions in your area. Soft water will cause little problem with mineral and lime deposits, but may form algae in

Continued

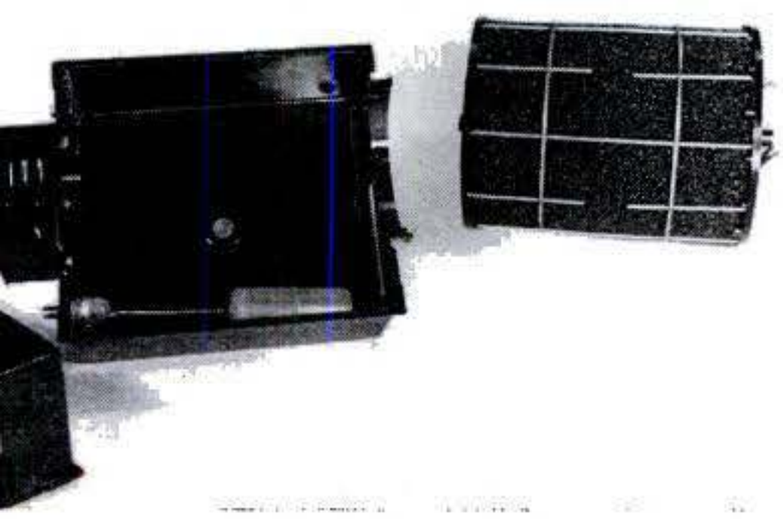
What you'll find inside various humidifiers



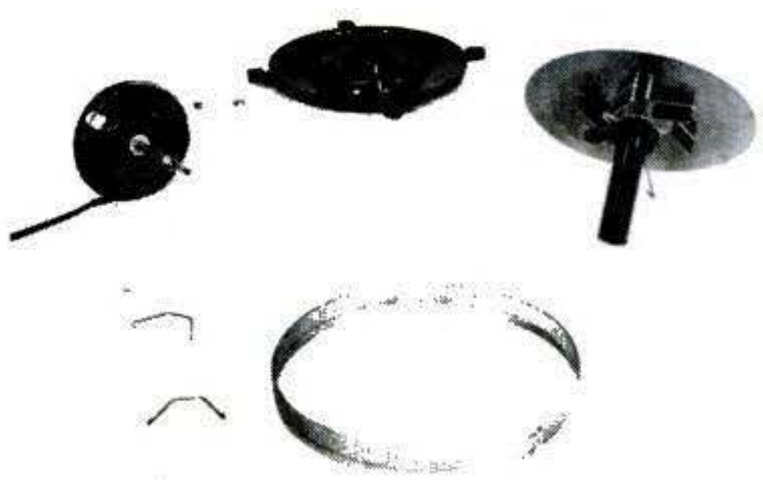
Evaporator pad is easily removed from a duct-mounted unit for cleaning and servicing. Plastic gauge on door front tells you when the pad needs cleaning.



Float-and-valve assembly are seen in top view of atomizing type. This unit is designed for concealed through-wall mounting in a home without warm-air ducts.

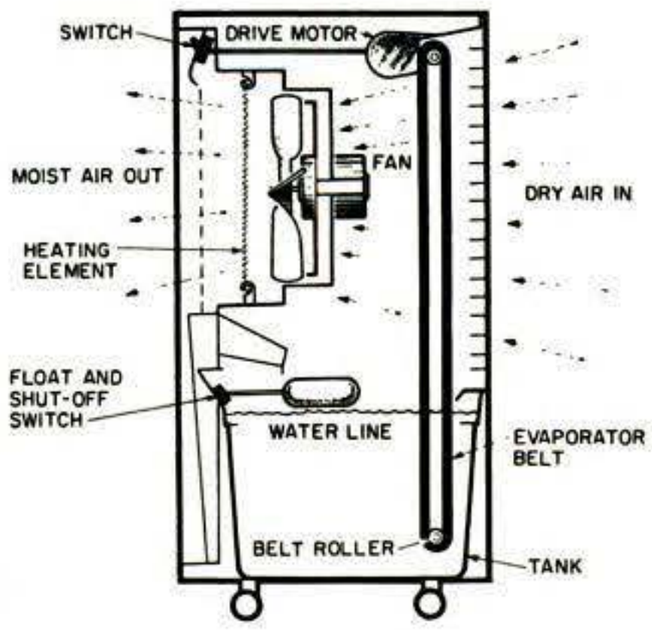


Revolving drum helps water evaporate in this one. The float visible in the sump regulates water flow. This humidifier goes between cold- and warm-air plenums.

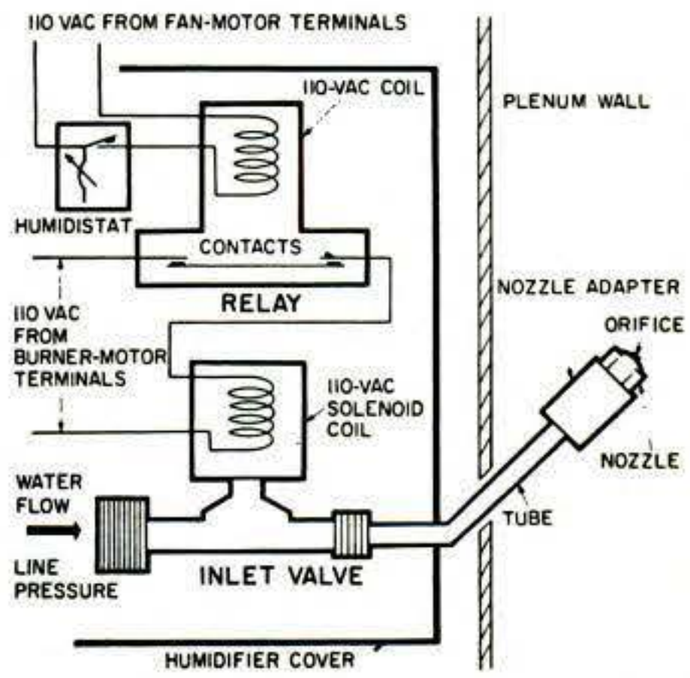


Components of this atomizing unit (viewed from bottom in clockwise direction) are: diffusing screen, its retaining clips, motor, motor base, and impeller.

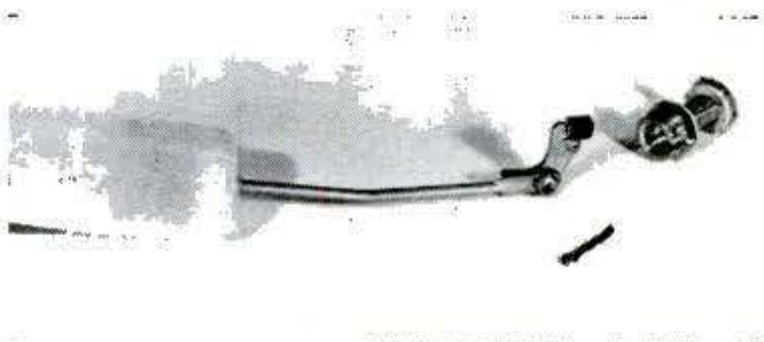
How both types of humidifiers work



In console evaporative-type humidifier, motor-driven evaporator belt slowly passes through water in bottom tank. Highly absorbent media is saturated before reemerging. Dry air, drawn through wet belt by fan, absorbs moisture (and is filtered at same time). This unit also reheats air to room temperature before discharge into room. Other evaporative humidifiers, such as duct-mounted units, use variations of this principle. Wetted media may be in form of drum, when it revolves through sump formed by tank, or it may be stationary pad saturated from sump or inlet valve.



In this atomizing humidifier, voltage from fan motor is applied across relay coil when fan motor is turned on by fan switch on furnace and humidistat contacts are closed. Inlet-valve coil, however, is energized only when relay contacts are closed and burner motor (or gas valve) is operating. With such a hookup, droplets spray from nozzle when fan runs, but spray turns off with burner. Fan continues to run, so warm-air flow through ducts evaporates remaining moisture. Since nozzle design and orifice size determine capacity, capacity may be changed by replacing the nozzle.



Float-valve assembly usually comes apart easily for servicing. A screw allows adjustment of water level. Replace valve if either the seat or plunger is damaged.

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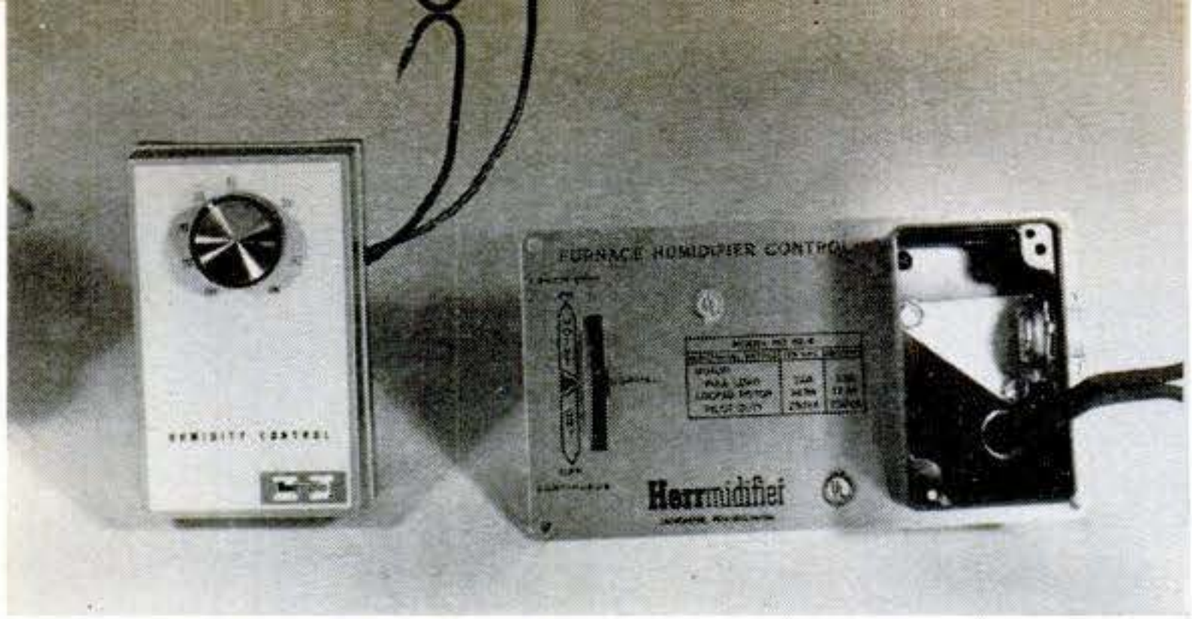
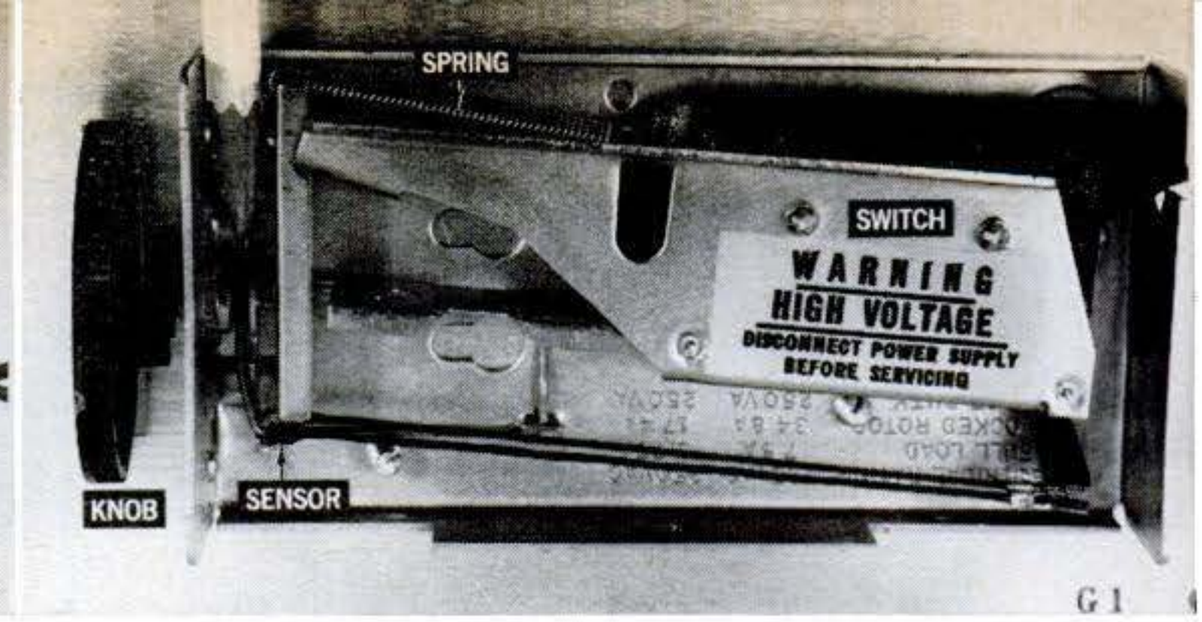


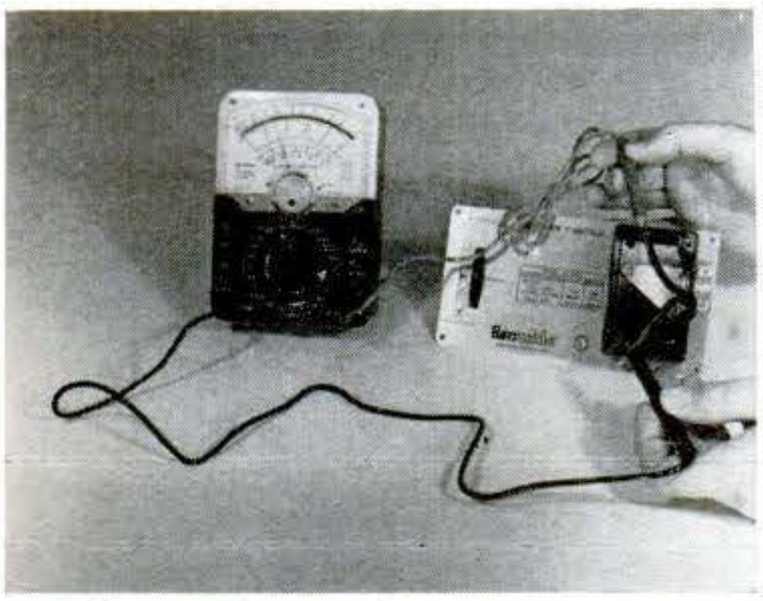
Here's help for solving humidistat problems: Wall-mounted humidistat at the left should be mounted on wall where it will be subject to average humidity conditions. Duct-mounted type at right goes on return-air duct to sample air moisture there.



Inside a typical humidistat, the knob turns screw indicated by the pencil, determining amount of tension placed on sensing strand (usually nylon or human hair). When moisture lets strand stretch and the spring acts, control switch is de-energized.

the system, and it must be removed periodically. This condition shows up as a green or brownish scum in the reservoir. Some manufacturers furnish chemical tablets to help eliminate the condition. A teaspoon of chlorine bleach, like Clorox or Texize, added to the humidifier at intervals, may help.

If you live in a hard-water area, mineral deposits removed from water during the evaporative process will eventually appear. This is not corrosion, and won't damage the reservoir. But if it becomes so severe that mechanical action is impaired, it may damage the motor or moving parts. The deposits can clog media material on evaporative types and the nozzles and impellers on atomizing types, and clog water valves on both.



Switch is easily tested with VOM. Connect on RX-1 scale, turn humidifier indicator to any position above room level, and the needle should sweep to 0-ohms resistance.

When disassembling a water valve, note proper location of each component. Lay out the parts in the order in which they're removed. Clean each thoroughly with an old toothbrush. A pipe cleaner is handy for cleaning small passageways and orifices. Be sure all parts operate freely.

On equipment using a float valve, look closely at the rubber button and orifice that admits the water. Some models have buttons that may be reversed when worn (wet soap rubbed on the button makes it easy to snap in place). On older humidifiers, water may have so badly eroded the orifice that the button will no longer make a tight seal when the float is raised. In such cases, consider replacing the entire float-valve assembly.

If you remove rollers or media wheels from motors, be sure the small rubber "slinger ring" on the motor shaft is reinstalled. It prevents mineral deposits from creeping up the motor shaft and into the bearings. In hard-water areas, a humidifier with a built-in flushing system will help keep down mineral deposits.

Electrical components. At most, there's an on/off switch, easily tested with a VOM; a motor, to drive an evaporative media belt through the water reservoir (evaporative type), or a solenoid that operates a water-inlet valve, allowing water to flow across a stationary media pad (evaporative type) or pass through the nozzle (atomizer) or into a pump impeller (atomizer); and many models also have a small fan motor.

These small synchronous motors and solenoids should be tested on a high resistance scale (Rx100) on a VOM. If open, they should be replaced. Be sure to check the mechanical gear train of the motor as well as the motor windings. Don't attempt manually to turn the wheels or rollers attached to the motor. It may damage the gear train and make replacement of motor components imperative.

If the humidifier won't operate at all, see if power is being supplied at the proper time. If not, test the contacts within the humidistat. They should read 0 ohms resistance when closed. Many duct-mounted humidistats won't close at all when humidity is above 40 percent unless a test position is provided on the control.

On some newer solid-state controls, voltage must be applied to the humidistat before the contacts will operate. The easiest way to test these controls is to turn off the power supply, clip VOM leads to the incoming line terminals, then turn on the power supply and read the voltage. Repeat with the output terminals.

In most cases humidifiers operate only when the blower is operating (although some suppliers of evaporative humidifiers now allow their equipment to be connected directly to line voltage, operating whenever the humidistat calls for increased humid-

[Continued on page 118]

Your Quick-Check Chart for Home Humidifiers

Symptom	Probable Cause	Remedy
No humidification or low humidification (also check calibration of instrument used to diagnose problem)	Dirty media pad, clogged nozzle or impeller	Remove and clean as necessary
	Clogged float valve or inlet valve	Disassemble and clean
	Binding media or pump motor	Remove, clean, and oil
	Open winding in media or pump motor	Replace
	Open contacts in humidistat	Calibrate or replace as necessary
	No power supply to humidifier	Check for voltage with VOM—check for open fan switch on furnace
	Furnace fan not operating long enough	Check setting of furnace fan switch
	Binding media wheel or pad	Check for mineral buildup or mechanical binding
	Undersize humidifier	Check sizing of equipment
Excessive humidification	Humidistat contacts stuck closed	Calibrate or replace as necessary
	Humidifier improperly connected to power supply	Check by diagram furnished with equipment
Humidifier overflowing	Stuck inlet or float valve	Remove and clean mineral deposit or replace worn components
	Clogged drain	Clean
	Capillary action siphoning water over case	Remove and clean mineral deposit
Noisy operation	Loose or binding bearing surfaces	Inspect and lube as specified or use silicone grease
	Interference from mineral buildup	Check and clean humidifier

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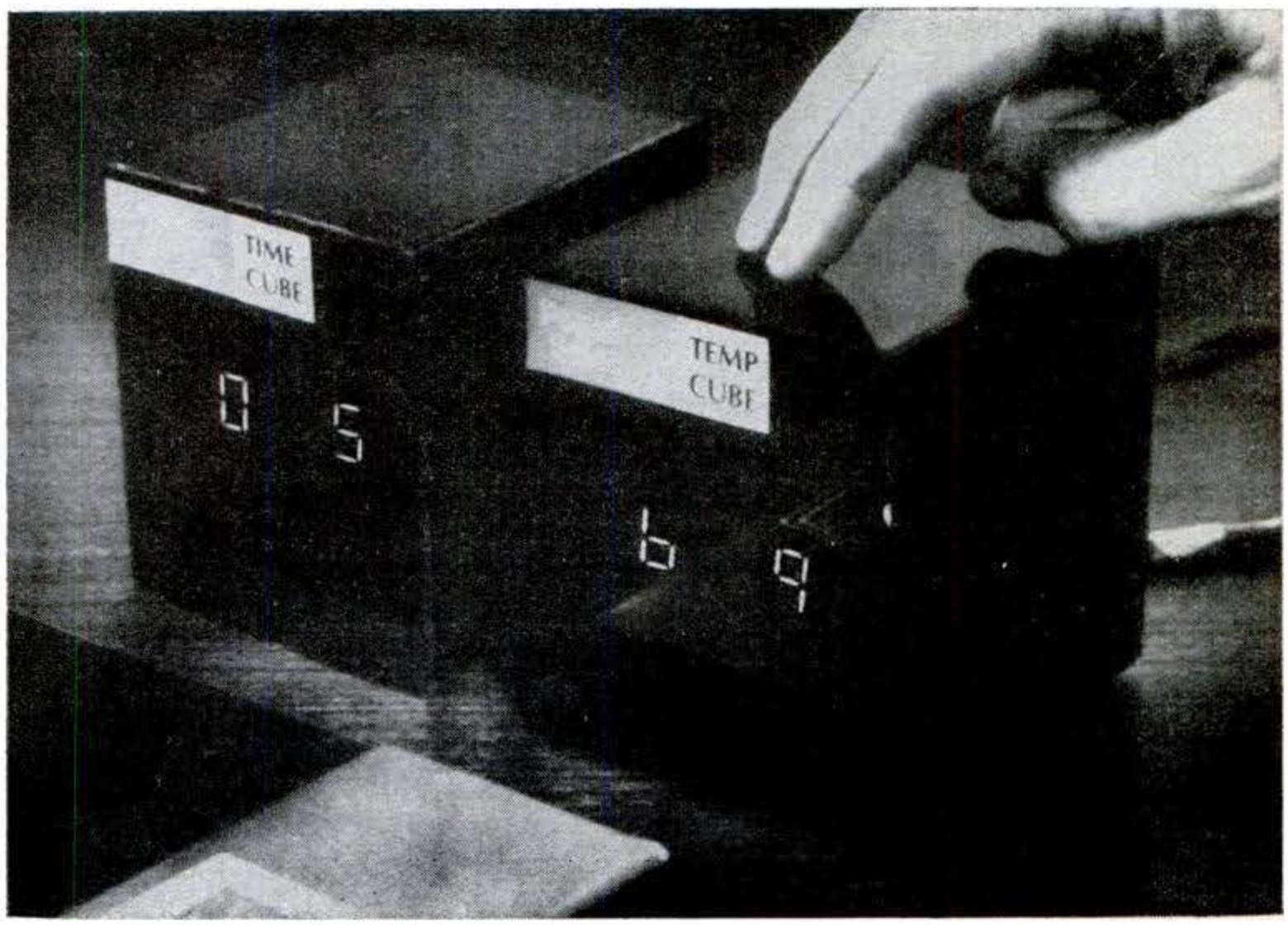
TEMP CUBE—a Digital Indoor/Outdoor Thermometer You Build

A perfect mate for the Time Cube, it tells you the temperature, inside and out

By WILLIAM J. HAWKINS
PS Electronics Editor



Remember the Time Cube last June? Well, now there's the Temp Cube—specifically designed to match the Time Cube. At first glance, it looks like a featureless, shiny black cube some four inches on a side. But as you watch, it flashes on, displaying the indoor—then outdoor—temperature in bright, orange-red, inch-high numbers that can be read across the room, even in total darkness.

Two switches under the cube allow you to program the display for any of four different readouts:

- Display probe #1: Indoor temperature is constantly monitored and displayed on the face. As the temperature changes, the cube follows, updating its display every second.
- Display probe #2: Same as #1, only *outdoor* temperature is displayed.
- Automatic scan: The cube automatically scans inside and outside temperature every four seconds. Each temperature is flashed on for one second; between scans the cube goes dark for two seconds.
- Manual scan: This is for the bedroom at night, when flickering lights can be annoying. Touch the cube's top and it will display indoor, then outdoor temperature. After this sequence, the cube blacks out.

Converting temp into digits. The Temp Cube makes its magic by an electronic trick known as analog-to-digital conversion. Basic temperature information is sensed by two thermistor elements—one inside, the other outside. A thermistor is a device that changes its resistance inversely as temperature varies—as temperature goes up, resistance goes down, and vice versa.

The thermistor is hooked into a circuit with a power supply and a new integrated circuit from Signetics called the NE 566, a function generator that generates a signal whose frequency is inversely proportional to applied resistance between two points. As temperature goes up, the resistance of the thermistor falls, and output frequency of the IC goes up.

To measure IC output frequency, the cube uses the 60Hz household current as a time base. The 60Hz line is divided by 6, equaling 10, then by 10 to equal 1 cycle per second.

It then counts the number of pulses generated by the Signetics IC during each one-second period. The circuit is designed so that this frequency

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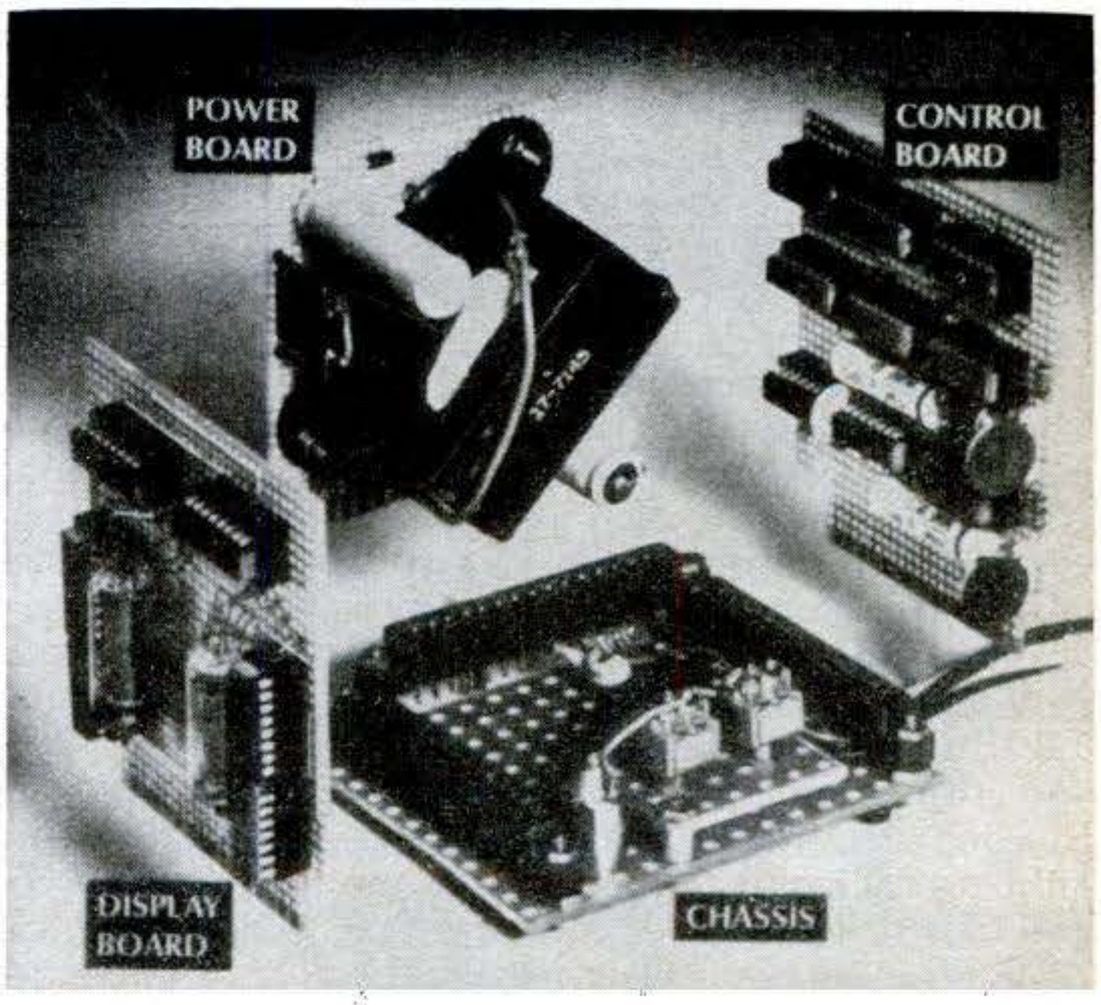

Plug-in circuit boards make cube a modular design that's simple to construct. Begin with the base first and carefully check fit as you go along. Rubber feet are glued to bottom of base to allow TRIP switch to actuate. Power-supply board will tilt in slightly, resting against socket bases of control board. Display board should stand straight up, without shorting back terminals to power board.

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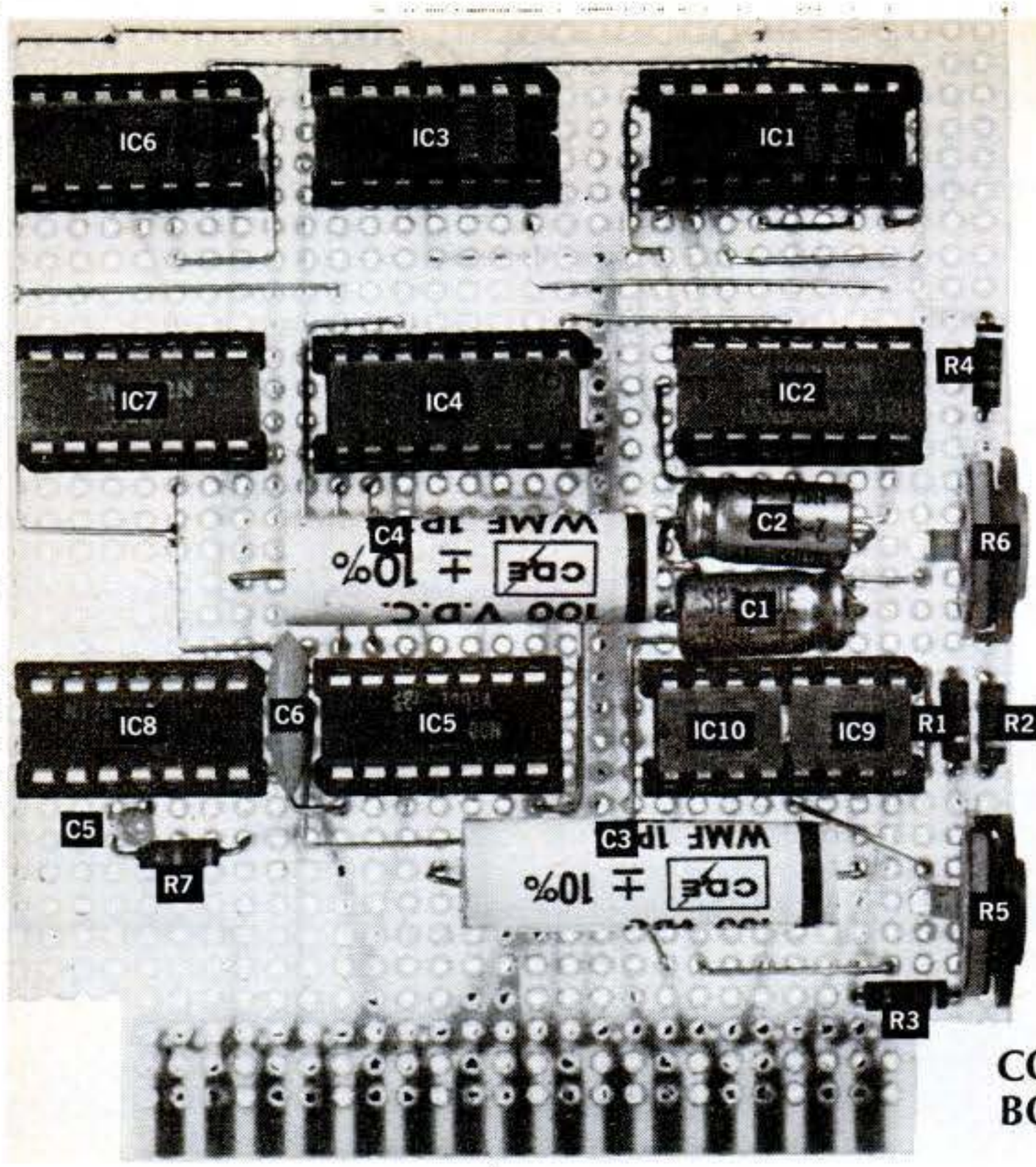
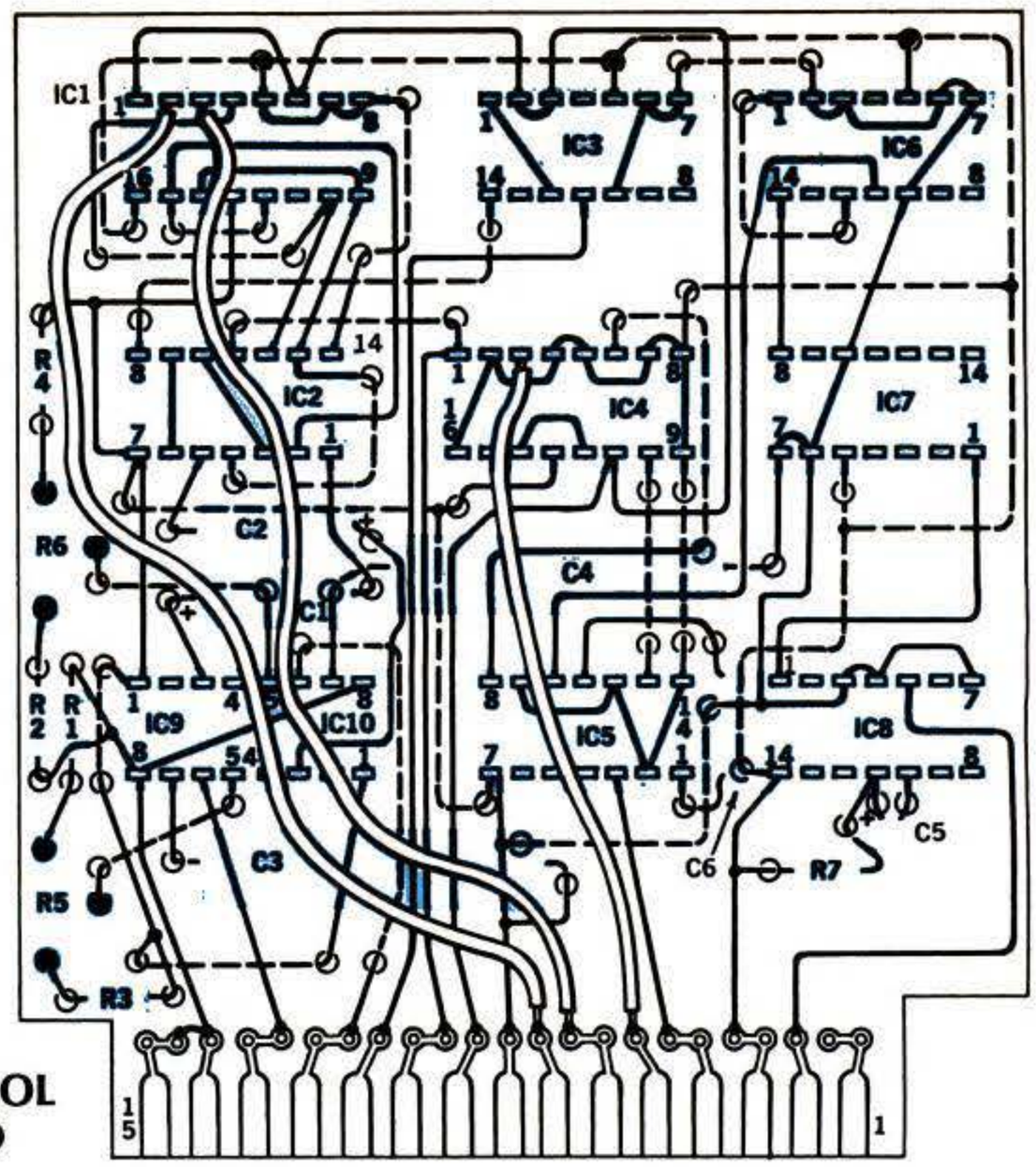
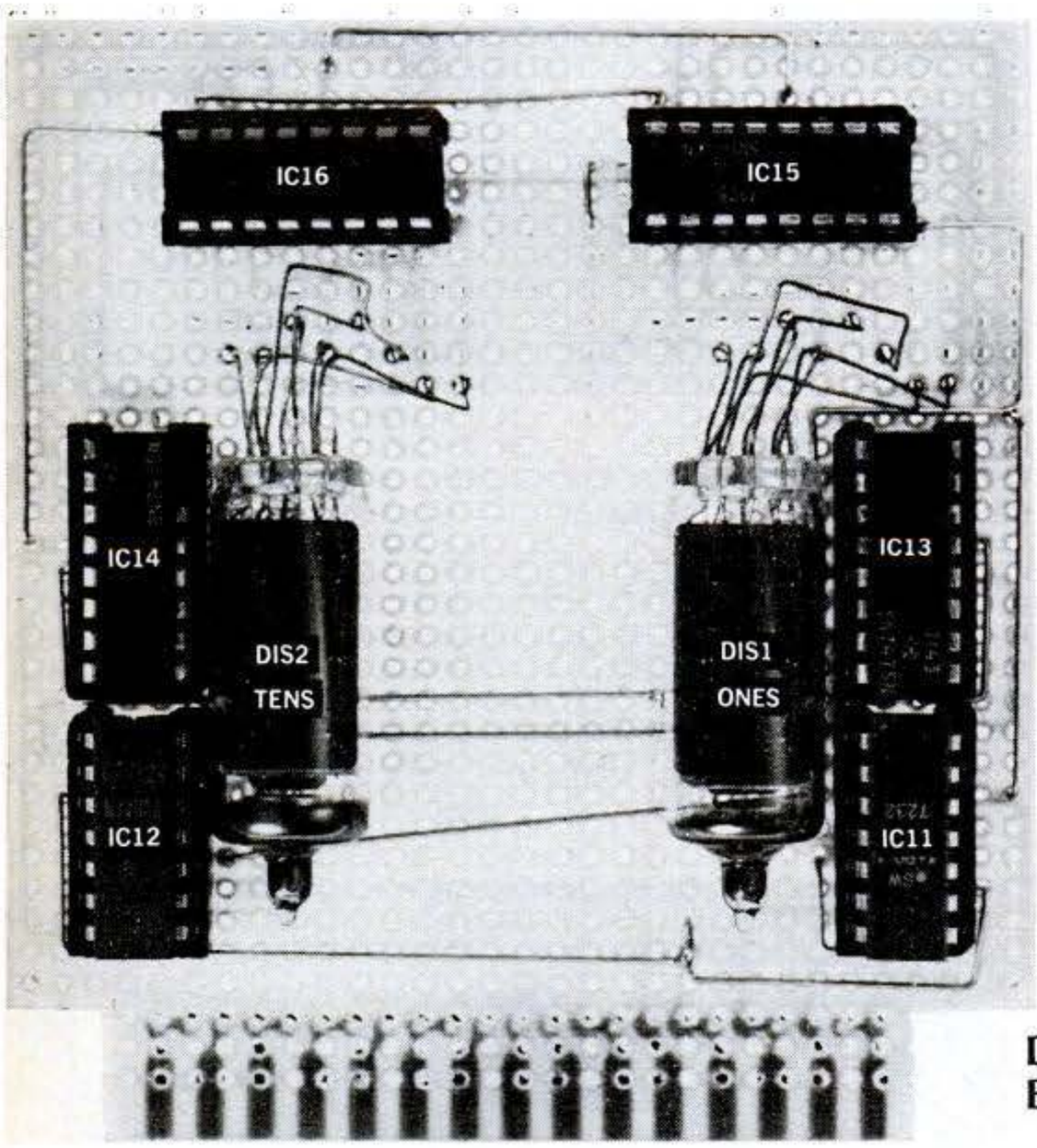
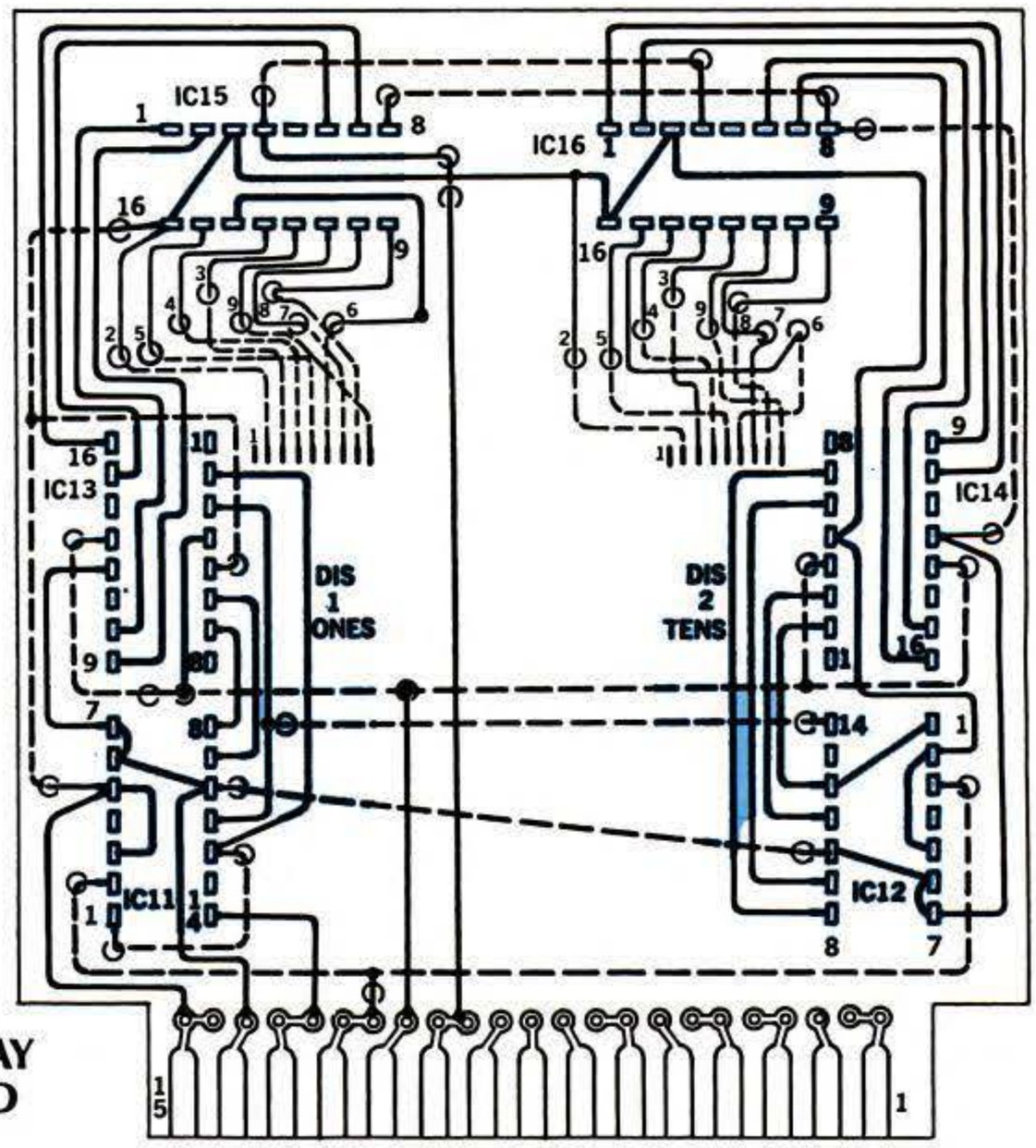




CONTROL BOARD





DISPLAY BOARD

equals the temperature. Two Signetics chips are used—one for each probe. Other ICs on the control board determine what function you've programmed and convert the frequency into a format the display electronics can interpret.

Displaying the results. The display board performs several functions before the temperature is read out. It accumulates the first temperature information (inside temperature) from the control board and creates a digital "word"—a series of electrical pulses. This word is stored while the second temperature reading begins to accumulate. The stored word is then passed on to the decoder/driver circuit, which reorganizes the pulses to illuminate segments of the display tube.

After one second, the displayed temperature is cancelled and the second reading, which now has had time to accumulate, is passed on, stored, and displayed. (The cycle continues so that while one temperature is displayed, another is being derived.)

Building it. The Temp Cube is not as complex as the Time Cube, but it is still not a one-evening job. Take your time, double-checking each board at its completion.

Use #22 bus wire for all point-to-point connections, #24 stranded for the exceptions shown. Be sure to stretch the bus wire before working with it to make all connections short, neat, and stationary.

Photos and drawings are full size, so you can use them for reference when cutting the boards. Check the exact fit as you go by building each section in this order: (1) base (use anything but metal), (2) control

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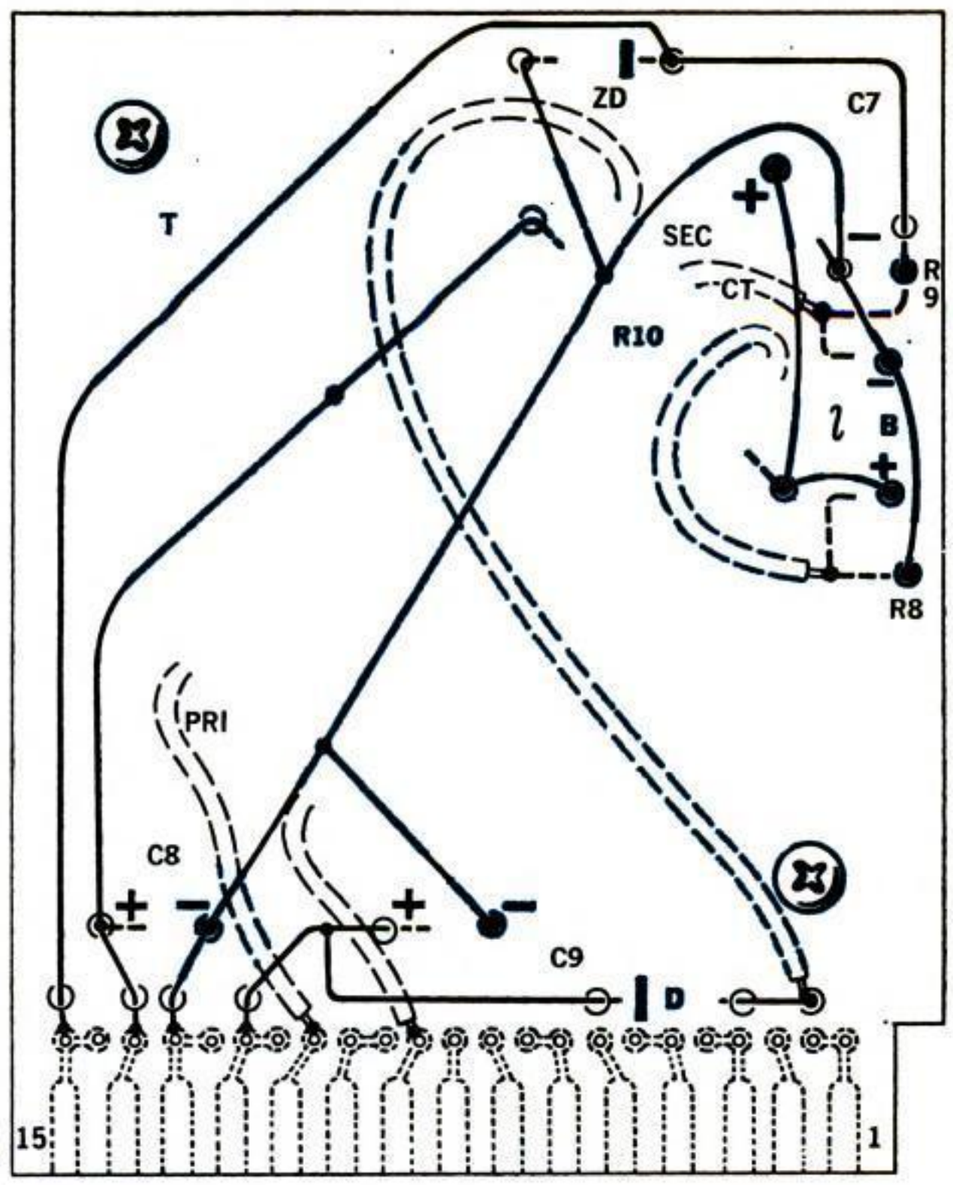
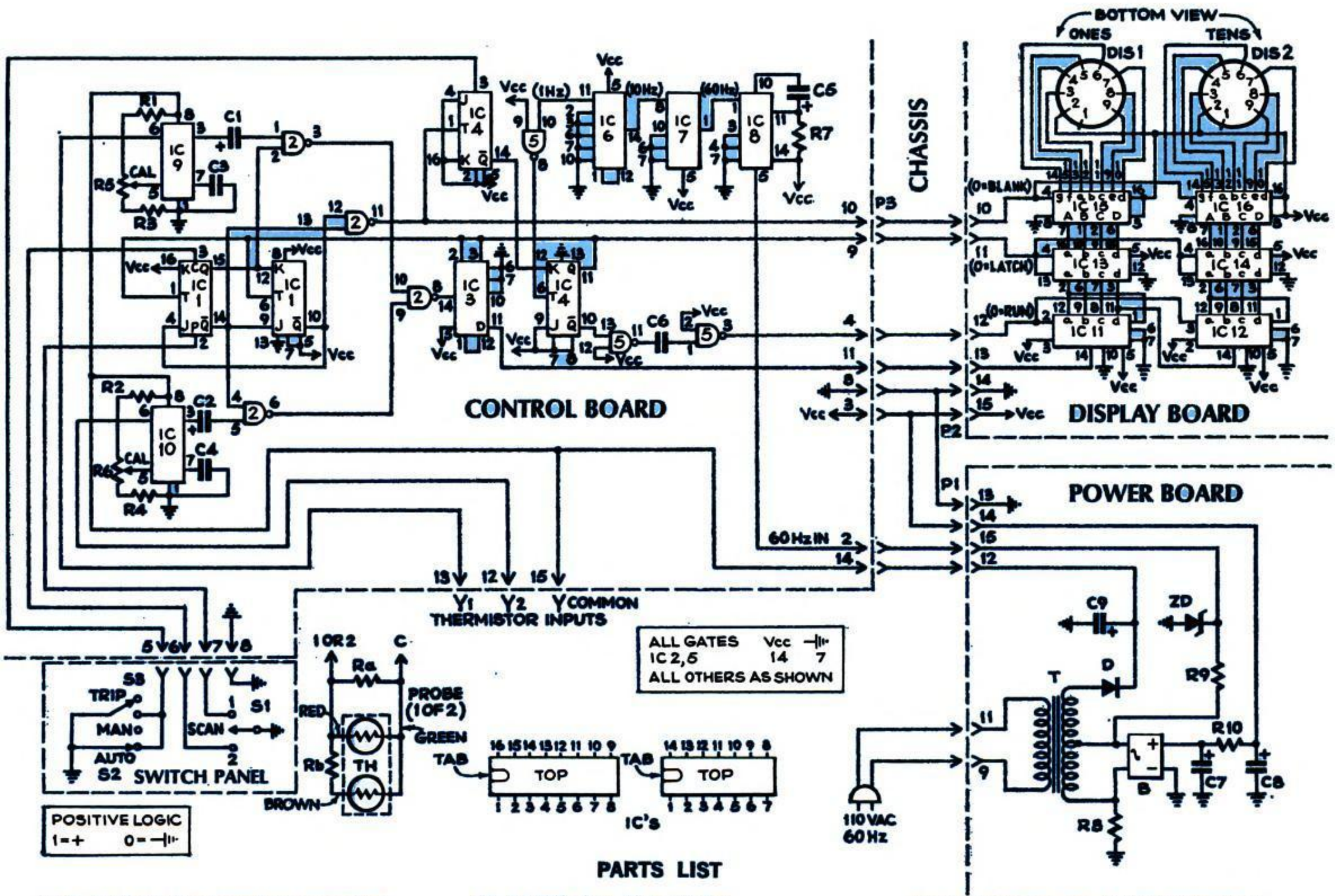


POWER BOARD



PARTS LIST

C1,2—2ufd @ 10v electrolytic capacitor
C3,4—.015 tubular capacitor
C5—.68ufd @ 35v electrolytic (Sprague 196D)
C6—.03 disk capacitor
C7,8—1000ufd @ 16v mini electrolytic (Sprague TVA-1163)
C9—250ufd @ 16v electrolytic capacitor
Ra—18,700-ohm, precision res. (supp. w/Th)
Rb—35,250-ohm, precision res. (supp. w/Th)
R1,2—1000-ohm, ¼w resistor
R3,4—9100-ohm, ¼w resistor
R5,6—1000-ohm, mini potentiometer

R7—30,000-ohm, ¼w resistor
R8,9—680-ohm, ¼w resistor
R10—1-ohm, 5w power resistor
$Th_{1,2}$—Thermistor network (YSI #44203)
D—diode (Motorola HEP 157 or equiv.)
ZD—5.1v zener diode (Motorola HEP Z0211)
B—1.8A rectifier bridge (Intl. Rect. 18DB2A)
IC1,4—Dual J-K flip-flop SN7476
IC2,5—Quad 2-input NAND gate SN 7400
IC3,6,11,12—Divide-by-ten SN7490
IC7—Divide-by-twelve SN7492
IC8—Monostable multivibrator SN74121

IC9,10—Function gen. NE 566 (Signetics)
IC13,14—Quad bistable latch SN7475
IC15,16—BCD-7 seg. decoder/driver SN7447
T—12.6V @ 2A CT power trans. (Triad F-44X)
$Dis_{1,2}$—7-segment display (Mura DA 133)
S1—2P3T (center off) mini toggle switch
S2—DPDT mini toggle switch
S3—SPDT mini pushbutton
3—15-pin board connectors and plugs
8—14-pin IC sockets
7—16-pin IC sockets
Misc.—Plexiglas, perfboard, bus, stranded wire

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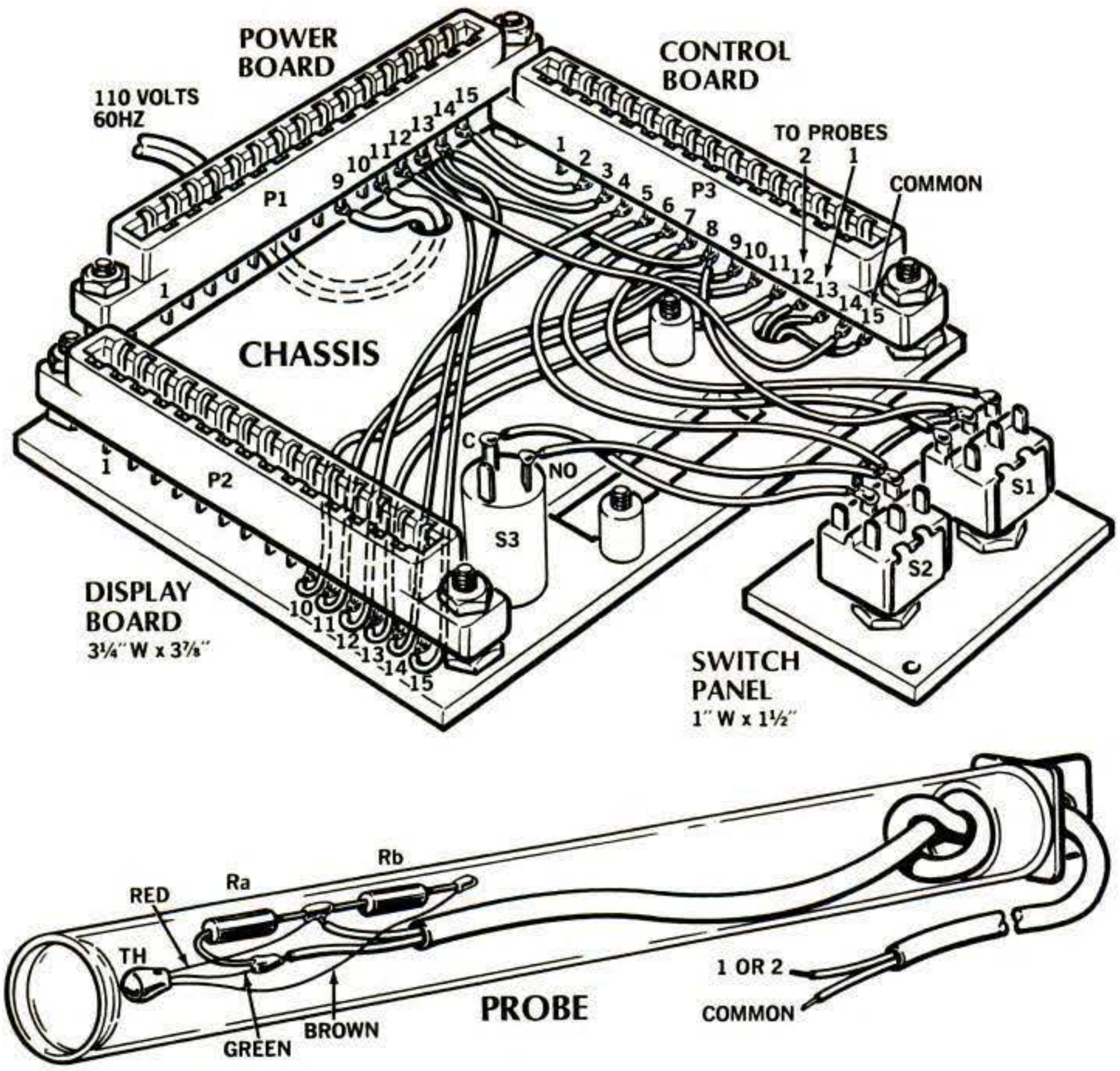


board, (3) display board, and (4) power-supply board. Make these from epoxy boards with hole spacings to match the IC sockets.

Mount S1 and S2 on a small piece of epoxy board and use ¼" standoffs to support it from the base.

The TRIP switch, S3, is the actuator for the manual-scan mode. Mount it so it just touches the surface on which the cube is placed. Pushing down on the top of the cube then compresses the rubber feet, allowing the switch to close.

Make the Plexiglas box last to insure proper fit. You can build the single unit or, as shown in the photo, a double housing for the Time and Temp cubes together.

The Probes. The thermistor network is made of two thermistors sealed in one package and the two resistors Ra and Rb (these resistors are supplied with the thermistor). Connect them as shown and use the plastic shipping container as a cover. You'll have to make two probes: one for inside and one for outside.

The networks are available through Yellow Springs Instrument dealers. A dealer who will fill mail orders is Bordewieck Engineering Sales Co., 221 Grove St., Braintree, Mass. They cost $11 each, including shipping.

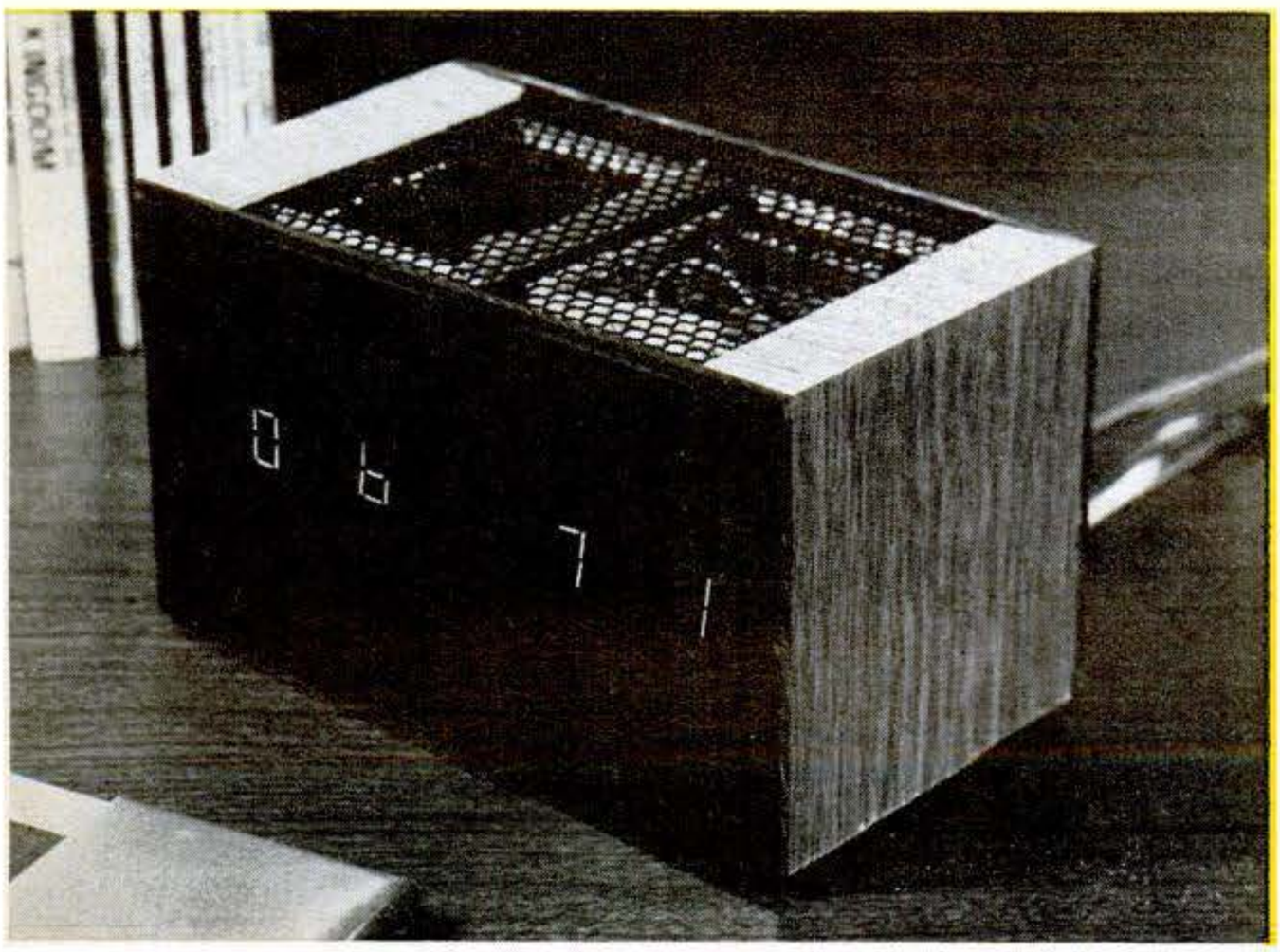
Other component prices will vary according to where you buy. Shop around for the best price, or consult the ads in electronics magazines. Williams Electronic Supply, 1863 Woodbridge Ave., Edison, N. J. is one mail-order source.

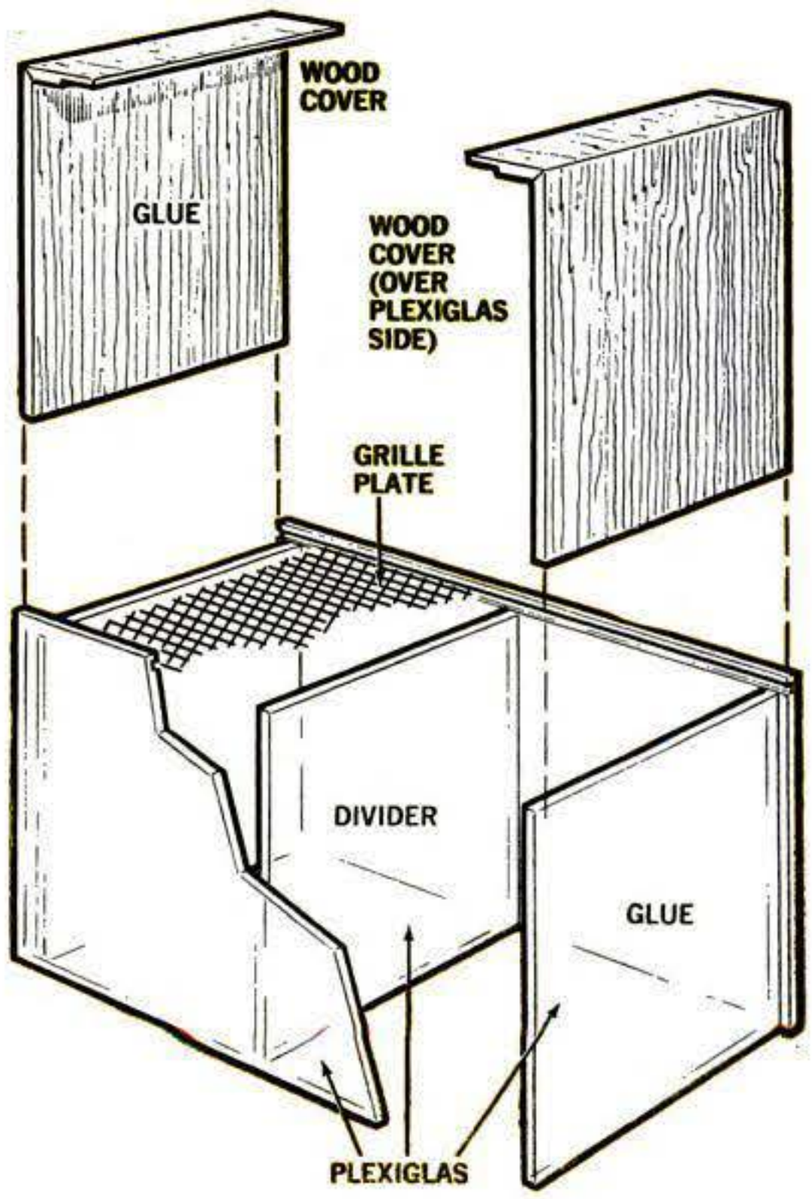
Calibration. It's simple. Potentiometer R5 calibrates the first temperature and R6 the second. Place the probes in a known temperature between 10 and 100 degrees F and adjust each pot slowly until the correct temperature is displayed. This is easiest if you have an accurate conventional thermometer to use as a standard. You can use any function mode that's convenient.

Once calibrated, you'll have to experiment with different probe locations indoors and out. The unit is very sensitive, quick to respond to temperature changes. So if you see a sudden dip in outside temperature, don't think the Temp Cube has gone haywire. It's probably just a cloud passing over the sun. PS

Time Cube plans. If you missed or discarded the Time Cube article of June '72 and want a copy, send $1.25 to: Time Cube, Box X, Popular Science, 355 Lexington Ave., New York, N.Y. 10017.

Double container for both the Time and Temp assemblies takes place of two individual cubes. Five pieces of Plexiglas make up four sides and divider. Inset two ends far enough to accept wood covers glued on top. Black decorator air grille slides in grooves in front and rear.





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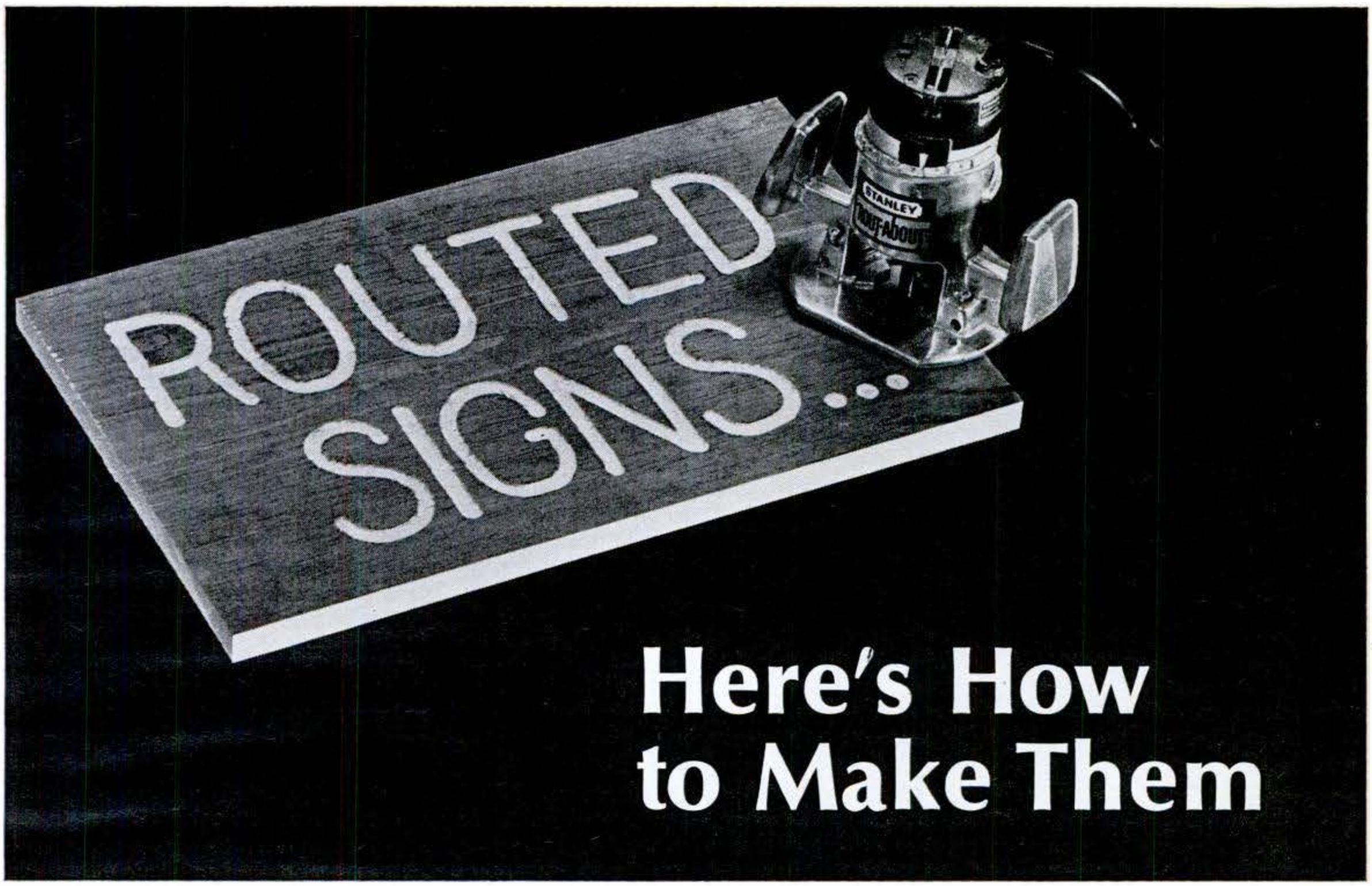
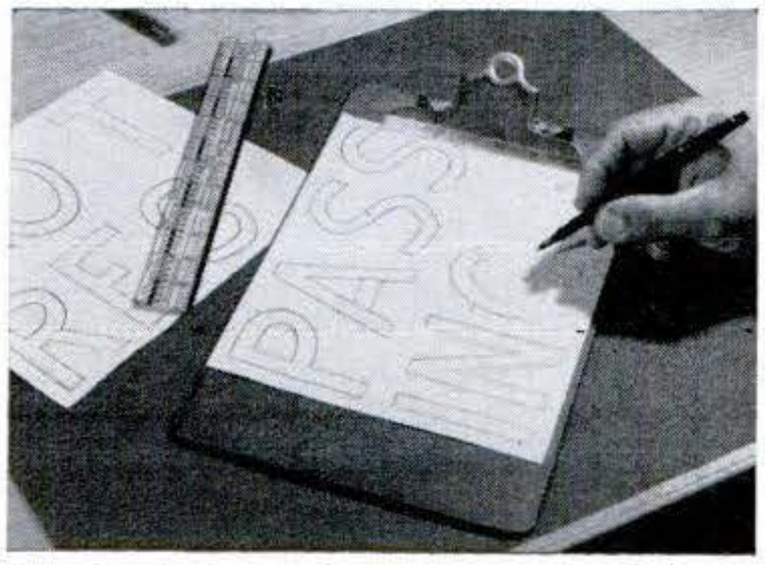


Here's How to Make Them

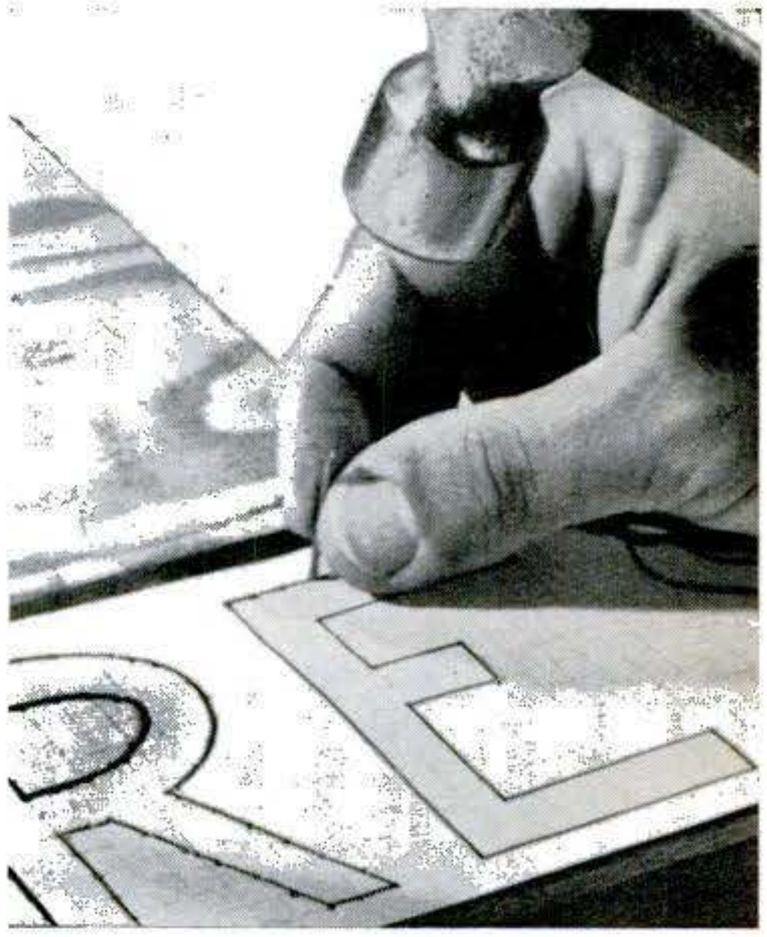
By MARSHALL LINCOLN

House numbers, street or family names, notices, warnings—whatever type of sign you need can have a natural outdoorsy look if you rout it in wood. Routed signs are especially suited to residential and rural locations, where they're a pleasant change from the stark, glossy styles you'll find in the hardware store. They're fun to make, too.

You should have no trouble laying out block letters and numbers on strips of graph paper. For more unusual letters and symbols, copy from book jackets or magazine ads, changing sizes to suit your needs. Or buy display alphabets that please you from an art store. PS



Quarter-inch graph paper is a big help in laying out your sign. Most letters have a width-to-height ratio of 3:5, but wide letters like M and W are almost square.



Transfer letters from paper to board by punching with nail or awl every quarter inch to form outlines. Use just enough pressure to make marks visible.

Rout carefully, starting with a shallow first cut, going deeper on a second pass. Stained pine will contrast with the letters, which are cut through to clean white wood.

Paint in letters with a bright color such as yellow if you've used redwood or another dark stock. Cover the sides as well as the bottom of the routed area.

Varnish or wood preservative goes on over the completed sign for weather protection. Don't use too much varnish or you'll get a glossy finish that kills the rustic look.

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Today's wall-to-wall carpets are a final touch of luxury living you can install yourself.

Install Your Own Wall-to-Wall... It's Easier Than Ever

Today's new fibers, tools, and techniques let you lay carpets like a pro

By EDWARD HALEMAN

There's hardly a room in the house that isn't getting the wall-to-wall carpet treatment these days. If you like the luxurious look and feel of carpets, but don't want to pay the installation costs—sometimes as high as $3 a square yard—do the work yourself. It's not as hard as you think.

There are three keys to a good job: The right tools, the right techniques, and the right attitude. The tools? You can rent them from most retail carpet outlets. The techniques? They're outlined here in 12 easy steps. The right attitude? Caution. Measure twice and cut once.

1 Tools come first . . . a knee kicker (top two tools here), a stapler, and tackless installation strips are usually all you'll need. Rent the tools, buy the strips.

5 Staple pad to floor after cutting it to fit inside (not on top of) the rim of tackless strips. We used a staple hammer, but an ordinary gun works just as well.

9 Kicking carpet onto spiked strips will stretch it oversize. Go back and retrim the carpet flush with wall and tuck the edge behind strip with blunt chisel.

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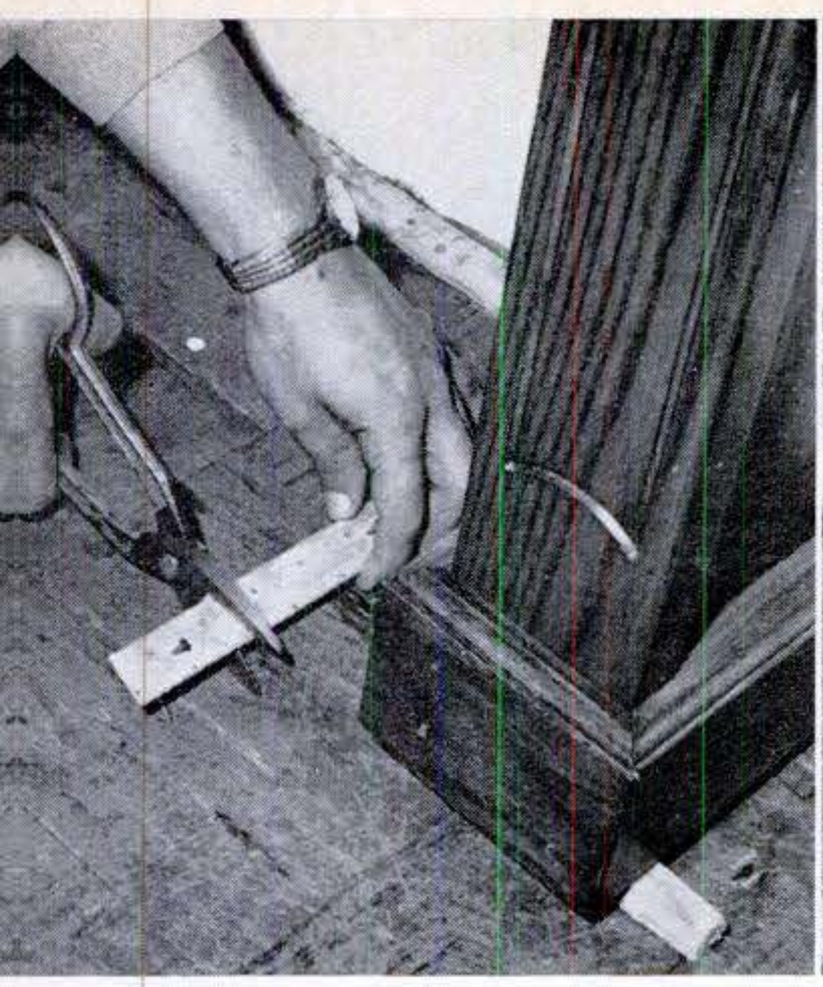
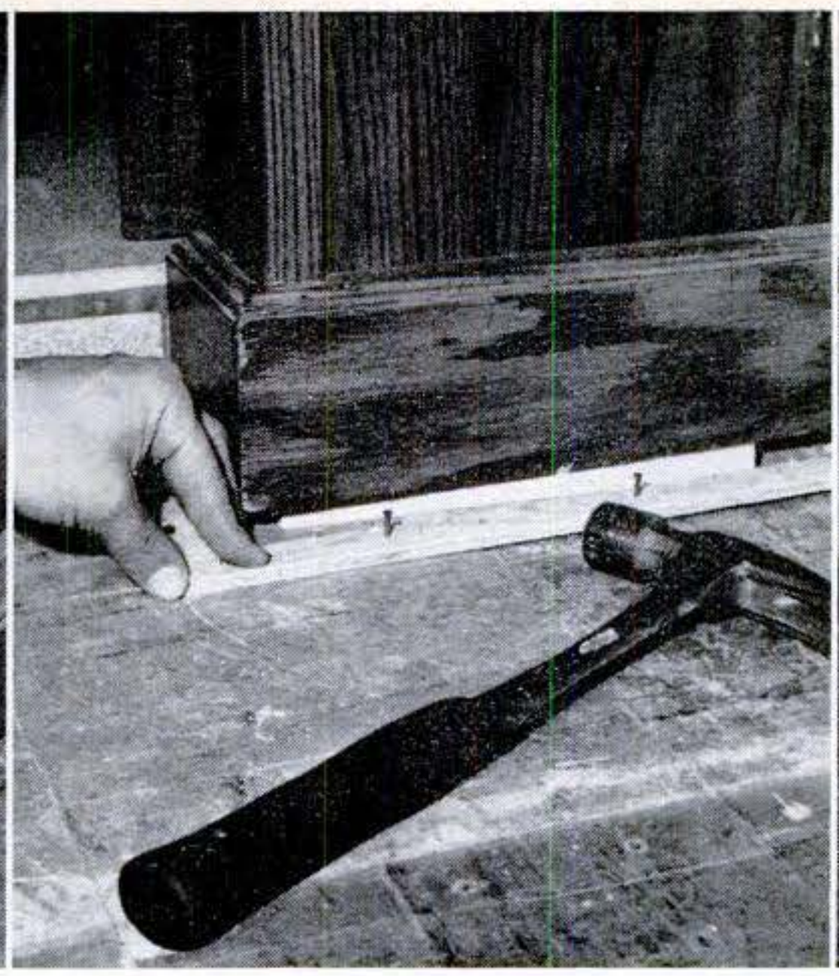
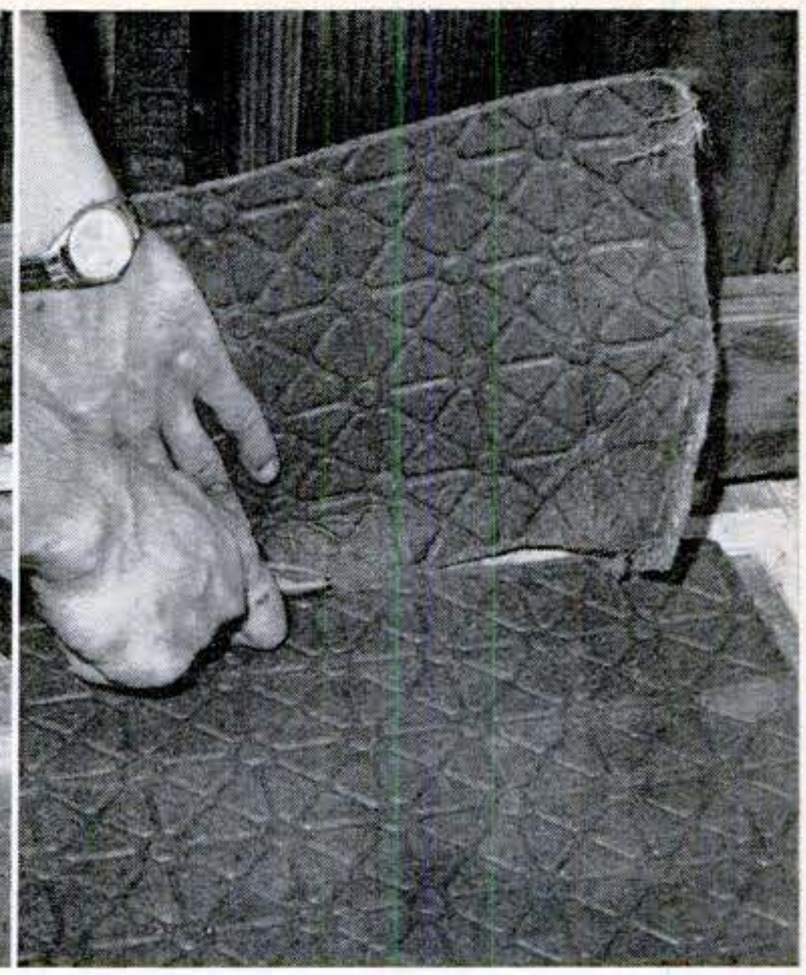


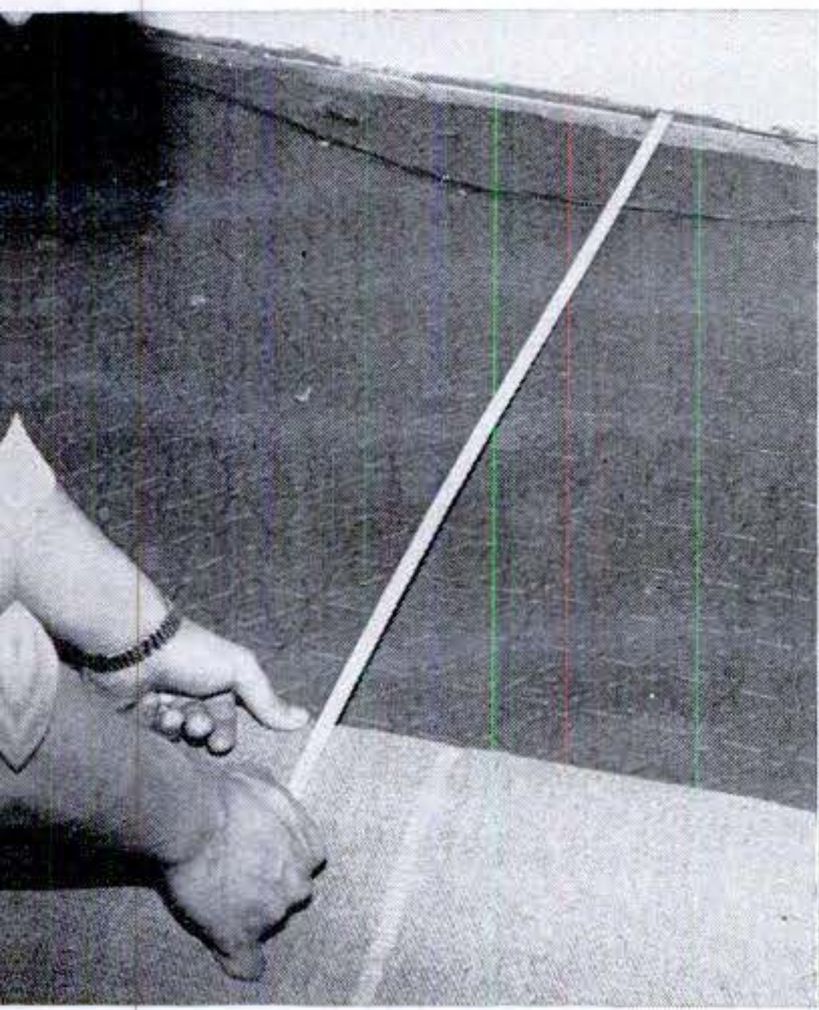
2 **Tackless strips** come pre-nailed in two types—one for wood floors, one for concrete. Easiest way to cut the strips is with a pair of ordinary tin snips.



3 **Nail the strips down** around the entire perimeter of your room. Note here that quarter-round base molding has been removed from wall for installation of carpet.

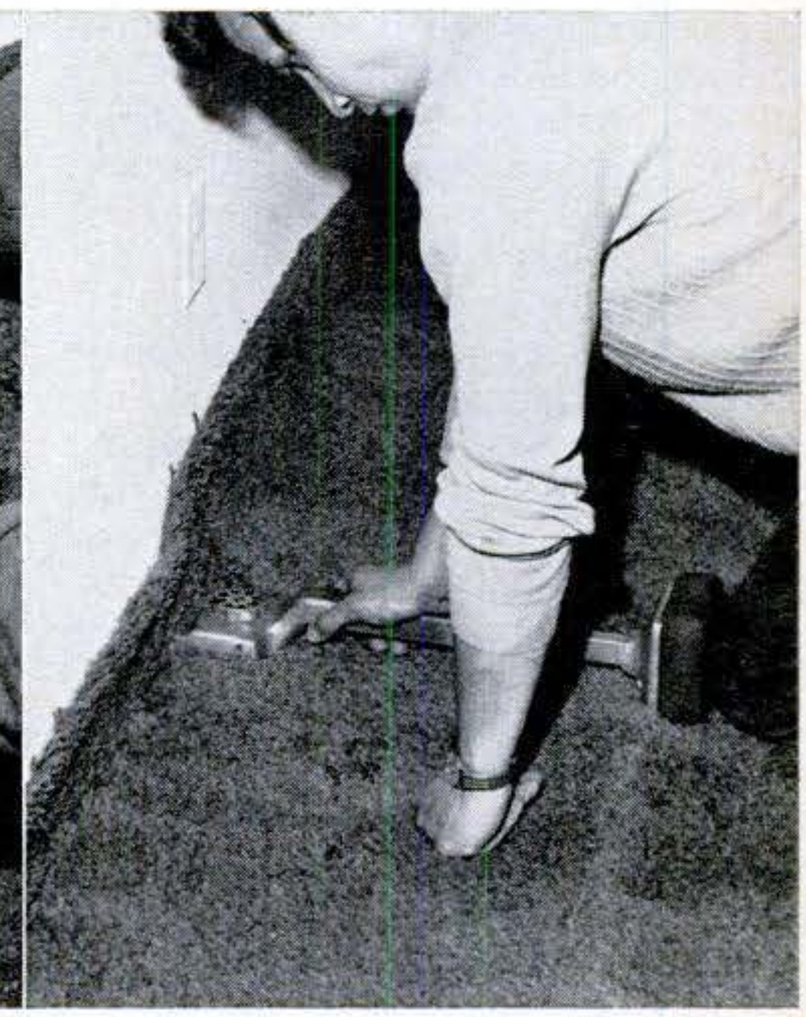


4 **Carpet pad goes down next.** Pads are sold in variety of weights and materials. Ask your carpet retailer to help you pick the right pad for your installation.

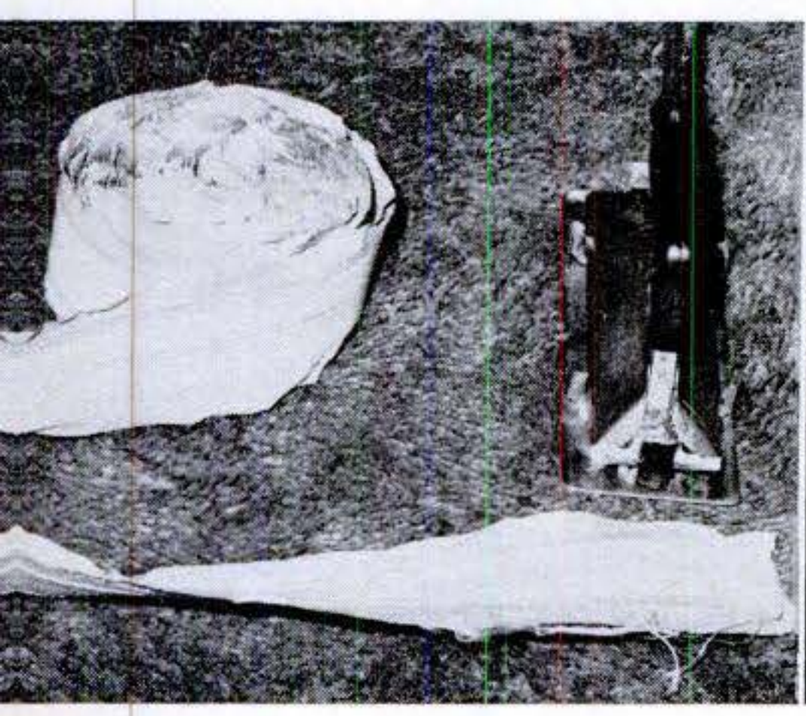


6 **Lay out the carpet,** leaving enough overlap to fit around built-ins. Measure—twice isn't too often—and cut carpet with a sharp knife so it's flush with wall.

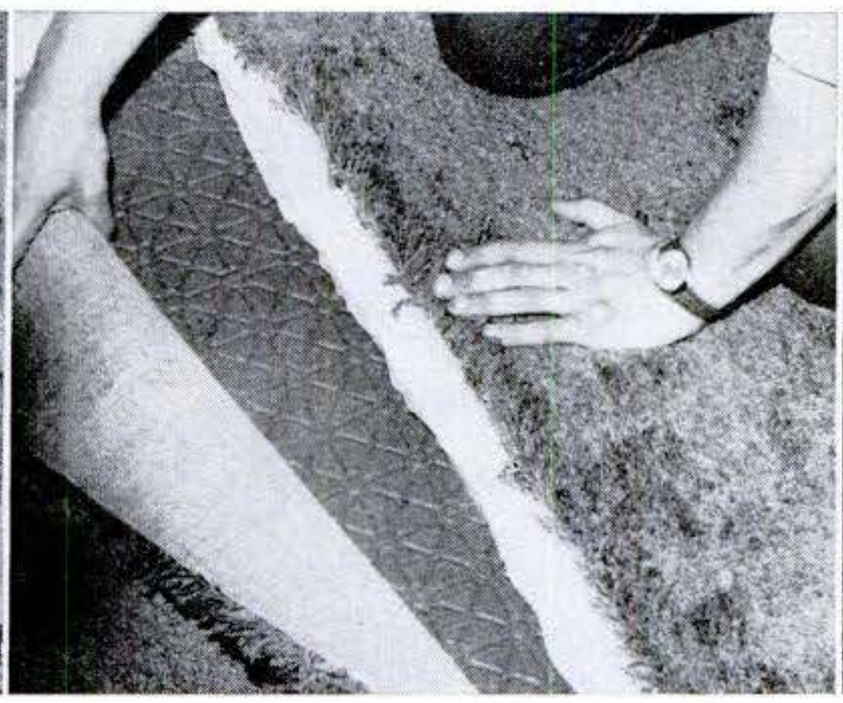
7 **Knee kicker** is to stretch carpet flat. Adjust dial so kicker's teeth will not dig into backing. Long piles take a high number; short piles, lower number.



8 **Start kicking:** Hold tool by neck, hit pad with your knee to push carpet onto tackless strip. Repeat along all edges until carpet is stretched tight and smooth.



10 **Need to make a seam?** Thermoplastic seaming tapes and heating iron make the job simple. First step: Butt edges to be joined, trim to assure a straight seam.



11 **Place the special thermoplastic** seaming tape under the carpet, centered on the seam line. Check to make sure everything is aligned properly, and proceed.

12 **Apply the hot seaming iron** directly to the tape. Move iron slowly along seam, pressing carpet edges together behind iron as you go. A helper makes job easier.

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HOW TO BUILD YOUR OWN

Reverse-Osmosis Water Improver

This homemade unit uses an Eastman membrane to demonstrate a new way of producing good water

By RICHARD DAY

Osmosis is the natural action by which one fluid, liquid, or gas passes into another through a semipermeable membrane. By osmosis, oxygen in your lungs enters the blood, and nutriments in soil water feed into tree and plant roots. A semipermeable membrane allows some substances to pass but stops others.

Reverse osmosis is the newest way of making high-quality water from poorer water. Application of pressure to one fluid, in this case the poor water, reverses the normal osmotic flow through the membrane. Small reverse-osmosis units are now in use to improve the quality of tap water. The process holds great promise, too, for commercial water purification.

You can build your own low-output reverse-osmosis water improver to illustrate the principles and possibilities of this scientific procedure. It will separate water from most of its impurities. Parts cost about $25.

Semipermeable membranes for water treatment are made from cellulose acetate and look much like milky celluloid. Eastman Kodak and others are seeking uses for such membranes.

Barry M. Brown and Elbert L. Ray, Eastman scientists, designed our homemade reverse-osmosis unit.

How it works. There's an outer pressure jacket and a perforated inner membrane cylinder. The cylinder drains through a pipe at its lower end. A pipe plug in the jacket's upper end gives access to the membrane cylinder, which threads in or out. The cylinder may be removed for membrane renewal. An inlet and valved outlet at opposite ends of the pressure jacket allow bypass of water under pressure. The parts list (end of article) shows everything you need.

The 2½″ and 2″ PVC pipes and fittings for the pressure jacket and inner membrane cylinder are stock items at most pump and pipe supply firms. If you cannot find them, substitute 1½″ and 3″ PVC or ABS pipes and fittings, common in plastic drain-waste-vent house plumbing.

Do not combine ABS parts, which are black, with PVC parts. Make ABS joints with ABS cement. If you will want to drink the product water from your unit, use only plastic pipes and fittings approved by the National Sanitation Foundation. These bear a small *NSF* designation.

Brown and Ray recommend that you use the unit only with potable water. "There are obviously ingredients the reverse-osmosis membrane will not take out," says Brown. Ray adds, "And faulty construction could result in improper functioning."

You can, though, get a good understanding of the reverse-osmosis process working with drinkable tap water and additives.

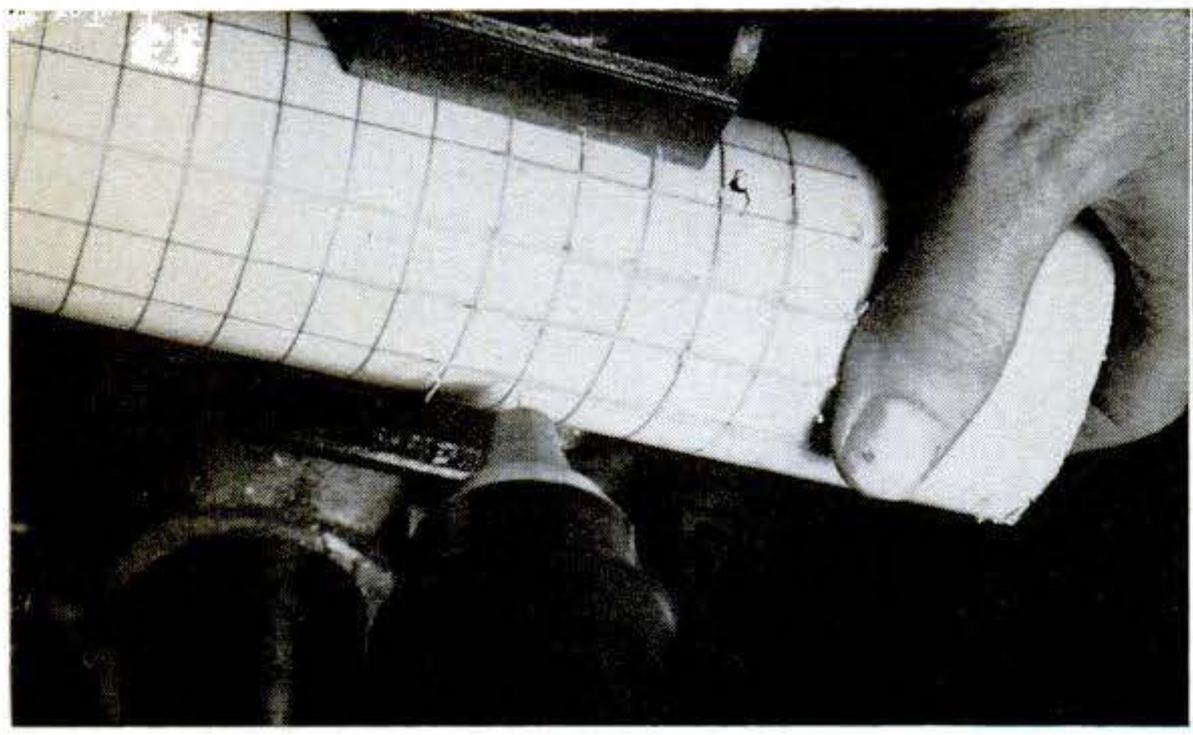
If getting sailcloth is a problem, substitute any closely woven porous cloth available in a yard-goods store. The rubber bands are like those used by rural mail carriers to bundle letters. Everything else is sold at most hardware stores. TFE tape is *Teflon* tape for use in place of pipe compound on threaded pipe connections.

You can get two semipermeable cellulose acetate membranes of the size needed by sending $15 to Eastman Chemicals Products, Plastics Div., Kingsport, Tenn. 37662. Ask for RO-98 Reverse Osmosis Membrane EDU Kit. Only a limited supply of these kits is available, so orders will be filled on a first-come, first-served basis. Orders received after February 15 will be returned to sender.

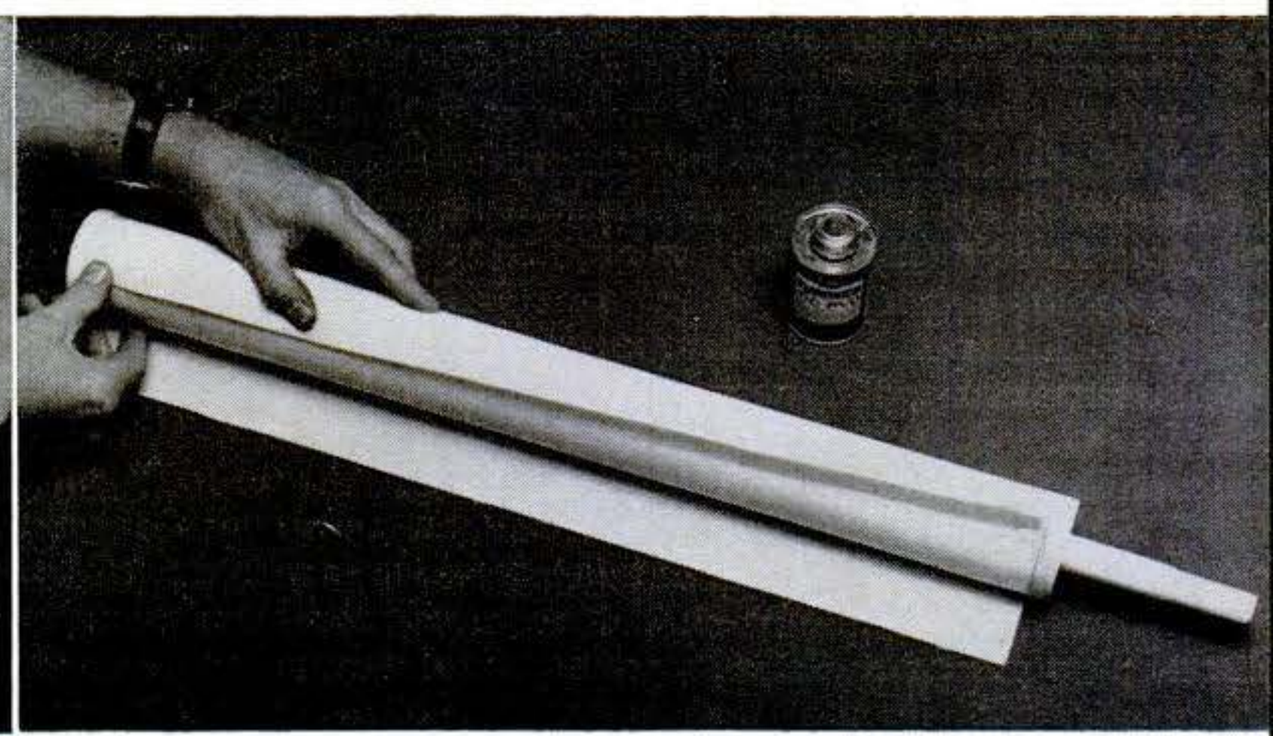
Making your unit. First cut all materials to size. Have a plumbing shop drill and tap the holes if you don't have the taps. Run the threads in 2″ on one end of the 5″ brass nipple. Remove the threads on both 2″ PVC plugs so they slip snugly into the pipe. We used an engine lathe, but any power sander would work. If the plugs haven't square hubs, hacksaw a slot across the untapped plug.

Turn out the inside shoulder of the 2½″ plastic-to-steel adapter flush with its inside threads. Again, a lathe works best but a half-round or round file also works well. Drill No. 60 holes on ½″ centers throughout the 2″ PVC pipe, leaving 1″ bands at each end undrilled.

Start assembly by wrapping TFE tape around the threads of the ¼″



First step in making the unit is the spacing of No. 60 holes ½″ apart in the membrane cylinder. To do this, use a drill press or an electric drill. As a guide, scribe lines ½″ apart each way on paper and tape the paper to the cylinder.



Cut a piece of sailcloth into a rectangle measuring 7½″ by 24″. Roll this heavy canvas around the membrane cylinder after spreading PVC solvent on both ends of the cylinder and the cloth. Place rubber bands around the ends while the solvent sets.

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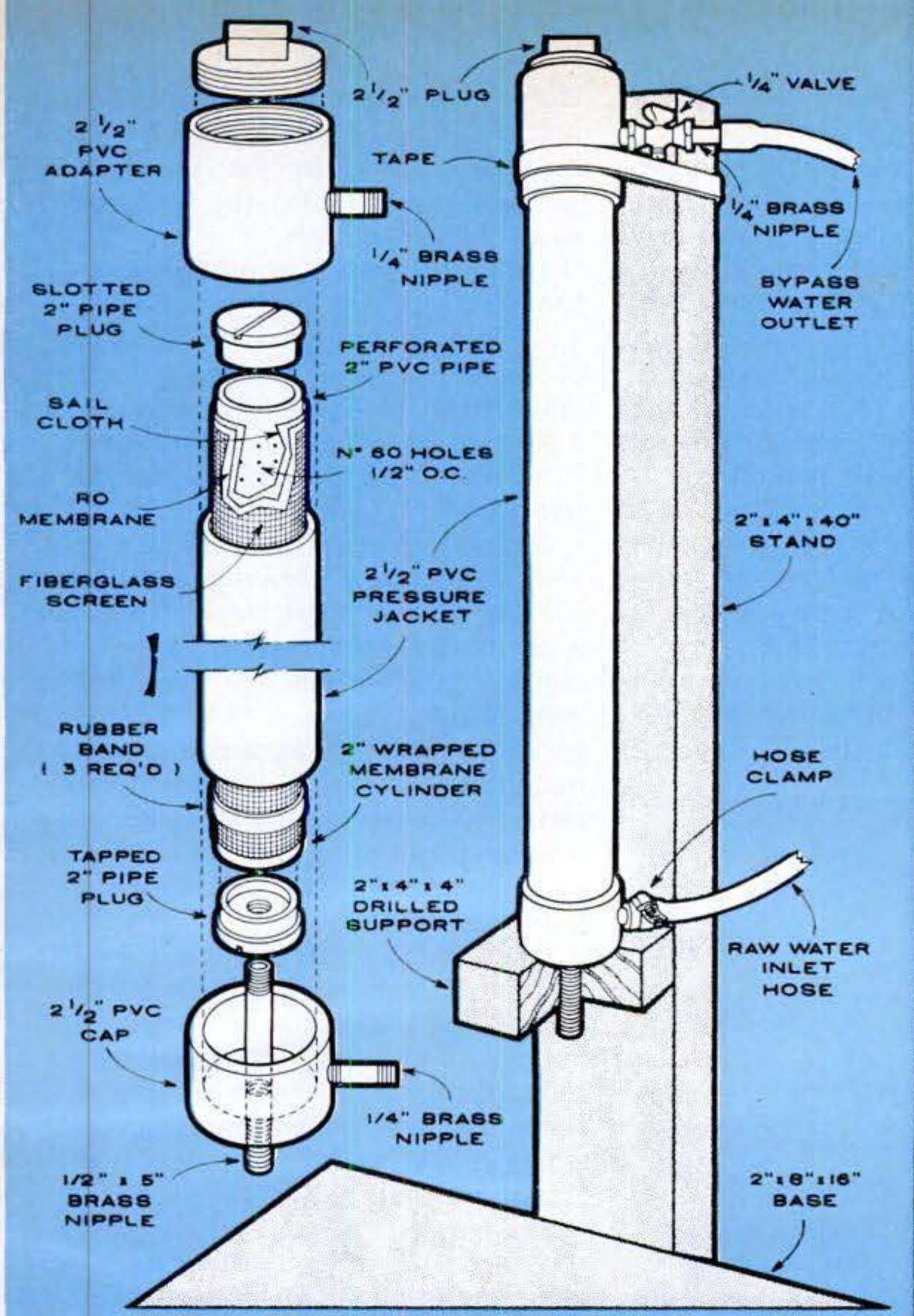

Turning the valve at the top of pressure jacket (right), the author controls water flow through the water improver. Compressed-air tank (a garden sprayer) is used to pressurize the raw water. The product water drips into container below the unit.

brass nipples and installing them. Install the flow valve the same way with the third brass nipple extending from it. Use the 1/4"-by-3/8" bushing if a larger hose must be attached.

Join PVC pipes and fittings with solvent, brushing it around heavily outside the pipe end as deep as it will reach into the fitting. Brush solvent lightly inside the fitting to its shoulder depth. Do not brush out. Assemble pipe and fitting immediately with a slight twist.

Cement the 2 1/2" cap on one end of its pipe. Cement the 2 1/2" adapter to the other end. Install both 2" plugs in the drilled 2" pipe. Screw the 5" brass pipe in the tapped 2" plug by its shorter threads.

Glue sailcloth around the 2" pipe with a thick coating of PVC solvent. Its purpose is to create a smooth base for the membrane without sealing off

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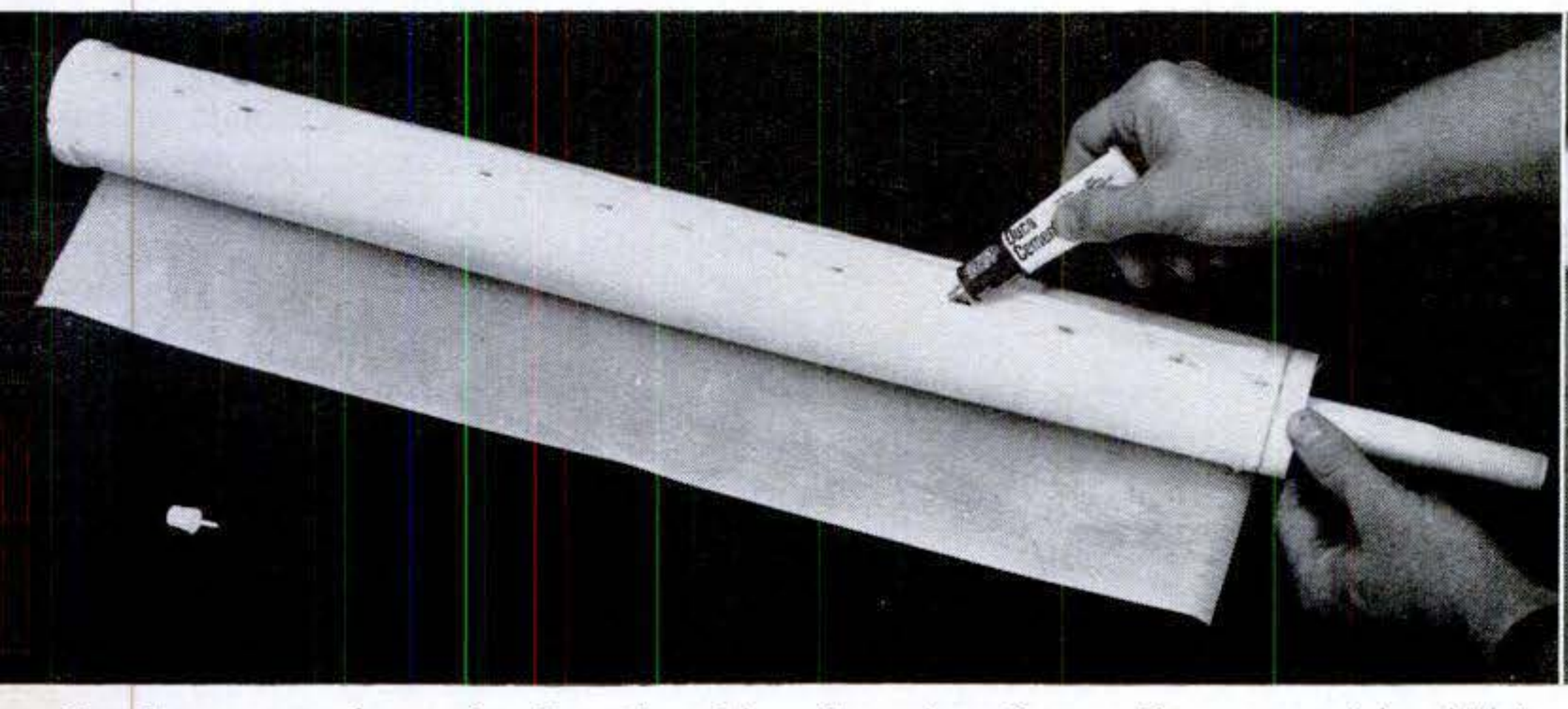
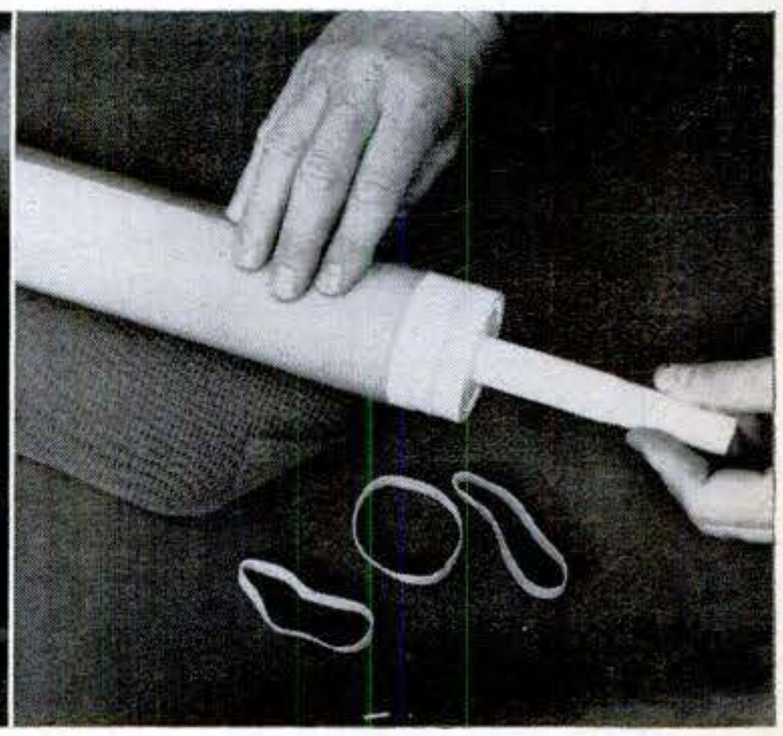


To glue on membrane, lay its active side down on soft surface. Center cylinder on it, sailcloth joint down. Roll up one side of membrane, mark cloth where edge comes. Spread continuous Duco cement bead 1/4" inside marks and on cylinder ends. Roll up membrane. Treat other side of cylinder same way, roll up membrane for tight seal.



Roll fiberglass screening around the membrane cylinder like this and snap on the five rubber bands to hold it in place. The screening protects membrane from damage.

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the No. 60 holes that you drilled.

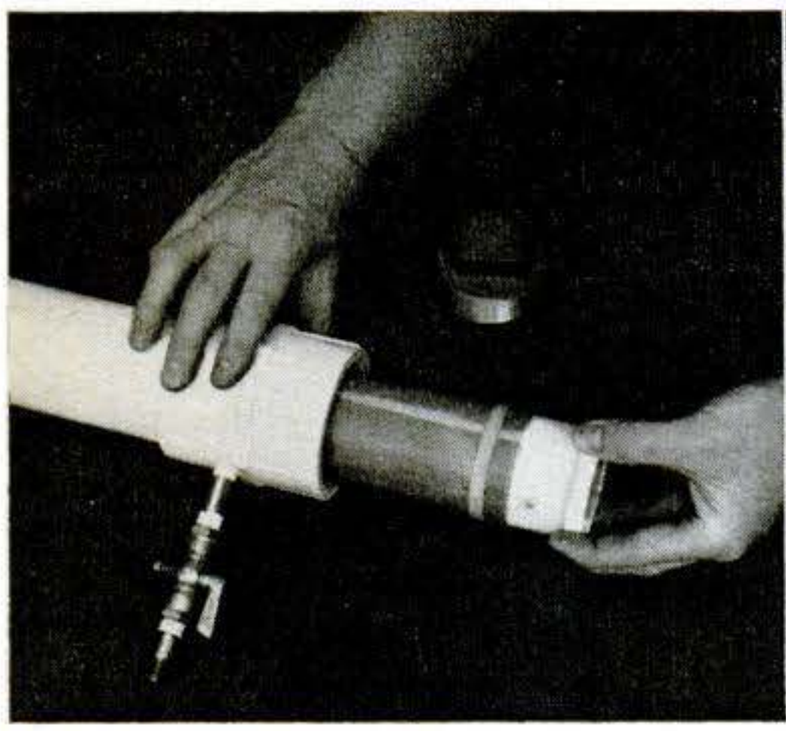
Gluing the membrane is tricky. Ends and center seam must be watertight. Folds, tears, and cuts in the membrane will permit leaks and destroy the effectiveness of your RO water improver. To glue successfully, spread the membrane on a clean, flat, soft surface, its glossiest, active side (specified on the RO-18) down.

Lay the 2" pipe across the middle of the membrane with the sailcloth's lengthwise seam down. Wrap one side of the membrane around the tube and mark its position on the sailcloth. Roll it back and apply a continuous bead of Duco cement ¼" from the edge mark; same at both ends of the tube. Roll the membrane up over the glue and seal it. Be sure it is stretched as smoothly and evenly around and along the tube as you can get it.

Glue the other side of the membrane including the lengthwise seam. Inspect, and use more glue on any doubtful joints. Let dry one hour.

Wrap the membrane in the fiberglass screen to protect it. Fasten with five rubber bands, evenly spaced. Insert the membrane cylinder into the pressure jacket. Wrap the threads on the 5" brass pipe with several thicknesses of TFE tape. Screw the cylinder in as far as it will go using the square hub or saw slot on the pipe plug to turn it. A putty knife is handy for turning a saw slot.

Install the 2½" threaded pipe plug in the end of the pressure cylinder after wrapping it with TFE tape.



Slide the membrane cylinder into pressure jacket. Before all the way in, TFE-taped threads will start into hole tapped in cap at other end. Screw in cylinder tightly.

Test water by taking ohmmeter readings before and after treatment. Tape leads together for equal spacing in tests. Coat upper half of each prod with Duco cement.

Suds test shows how the hardness of water was reduced by treatment in the reverse-osmosis water improver: Treated city water, at right, compares favorably with distilled water. Note the low suds line of the untreated water in the bottle at center of photo.

Test results author got from his RO unit

WATER TESTED	RAW (ohms)	TREATED (ohms)
Bottled "distilled"	475	—
Mountain spring	60	72
Heavily chlorinated spring (sodium hypochlorite)	35 (smells & tastes of Cl)	56 (Cl reduced to normal levels)
San Diego city	35 (very hard)	58 (very soft)
Salt (¾ tsp./gal.)	49	60
Detergent (1 tsp./gal.)	80 (1⅜" suds layer)	74 (no suds, good taste)

Build a wood stand and mount the RO unit in it. The 5" brass pipe slips through a hole in the two-by-four support block. Hold the top with a wrap of filament tape.

Using the unit. Cut off the outside-threaded end of a ½" garden hose and clamp this to the pressure jacket's inlet nipple. Turn on the water and adjust the brass bypass valve for a flow of about ½ pint per minute. Continual flow-through of water is important. Check for leaks.

Soon product water will begin dripping from the 5" brass pipe. If the flow is greater than three drops per second and if ohmmeter tests (described later) show no lessening of conductivity between raw water and product water, there is a leak in the membrane or one of its glued joints. Remove the membrane cylinder, strip off the membrane and sailcloth and start over with fresh sailcloth and your spare membrane.

I learned the hard way that the RO membrane cannot be allowed to dry and then be used again. Brown and Ray explain that drying destroys most of the membrane's *flux*, its ability to pass product water. As a result, water collection falls drastically after it is once dried.

Making tests. Attach the unit to a pressurized garden sprayer with its reservoir filled with salt water or detergent water, and you can test your water improver with real roughies. This demonstrates the use of reverse osmosis in the reclaiming of polluted water. Don't exceed pressure limits of the PVC pipe, though, or you'll blow the whole thing.

We learned a few other things in early tests with our RO unit. For one, it didn't improve seawater at all. Brown and Ray explain that the osmotic pressure of seawater is about 350 psi. We didn't stand a chance with a working pressure of only about 50 psi. Units to treat seawater use extremely high pressures.

Even with a low pressure, however, you can test your RO's salt rejection. Make a low-concentration salt water by adding three teaspoons of table salt to four gallons of water. Our results with this solution are shown in the table. Collection was slow because of the small difference between our working pressure and the solution's osmotic pressure.

To compare waters before and after processing, use an ohmmeter with its two leads taped together by their insulators. This spaces them the same distance apart for all tests. When testing, the leads must be immersed in the water exactly the same distance each time, and the container should be the same, too. High ohm readings indi-

[*Continued on page 126*]

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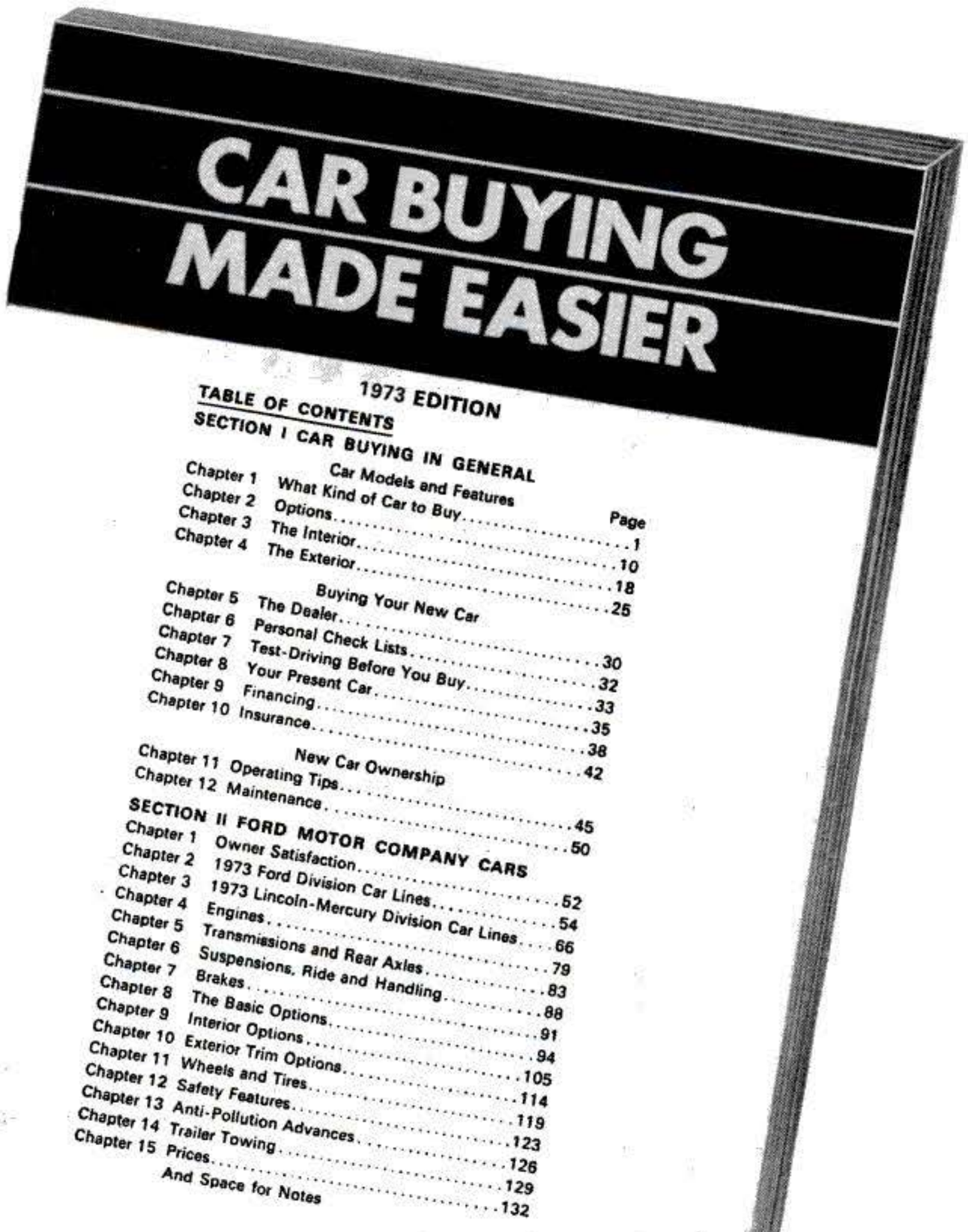

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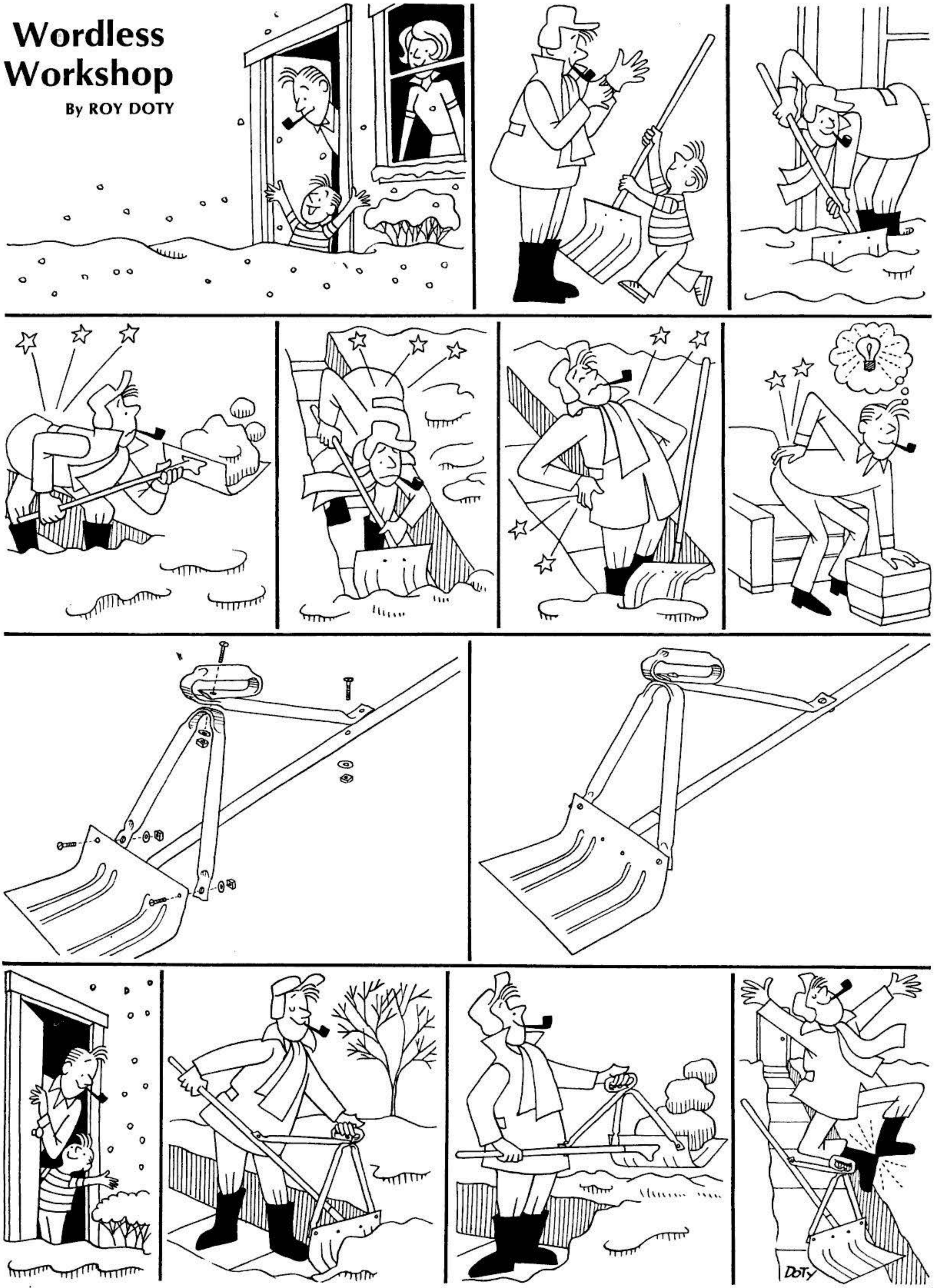
Wordless Workshop

By ROY DOTY



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Get away from the crowd. Get the flavor you want in Old Gold Filters.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

20 mg. "tar," 1.3 mg. nicotine av. per cigarette, FTC Report Aug. '72.

Author E. P. Haddon is former chief of visual information for the U.S. Fish and Wildlife Service. He has worked throughout Alaska documenting Eskimos and traveled widely in the high Rockies.

FOR MORE WINTER FUN

Strap On Your Snowshoes and Backpack

Snow-trekking is great when you're well prepared for it. Here's an expert's advice on how you can enjoy this cold sport

By E. P. HADDON

Wherever there's snow, cross-country treks and winter campouts have mushroomed into a booming sport.

It's not exactly a new fad—I've been doing it for more than 40 years. But snow-trekking is enjoying unprecedented popularity because new space-age gear, combined with a little know-how, enables you to enjoy back-country wilderness outings in frigid temperatures that would have kept pioneer woodsmen shivering over their fires.

Let me share some of my know-how with you, along with some tips on up-to-date equipment for snow-trekking—and maybe you can join this popular sport, too.

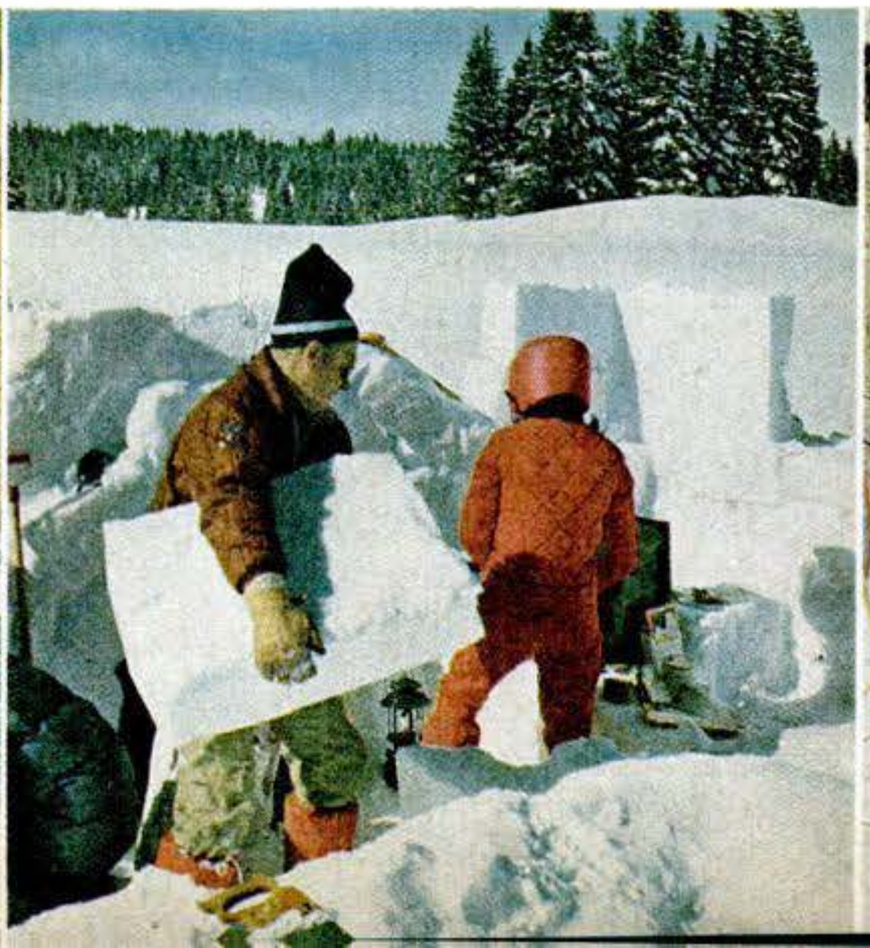
Clothing you'll need. For extended trips, my packs weigh out at about 50 pounds. My clothing is warm enough to help me survive an emergency without the need to build fires. And I've found that it's better to wear several lightweight garments than a single heavy one.

The best vests and parkas for this sport are made from nylon filled with down. I've found down to be the most efficient insulation available, ounce for ounce, and it can be compressed to small dimensions for carrying. Yet it returns quickly to its original size.

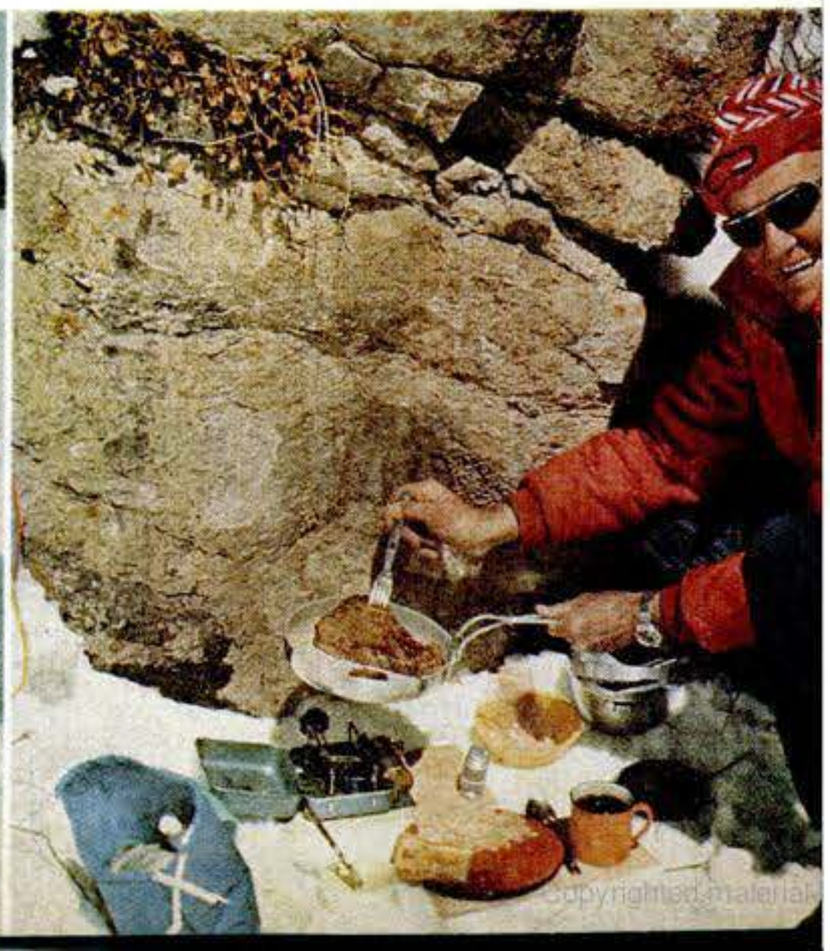
Since being pinned down by a blizzard overnight in

Tents designed for snow camping come with tunnel entrance that can't freeze up. Under really severe conditions, zippered openings can be difficult to open and close.

Cutting snow blocks with a carpenter's saw makes construction of a windbreak for camp easy. Some outdoorsmen build snow-block igloos, preferring them to tents.



Small camp stove is handy for cooking warm meals for winter campers—and for melting snow into drinking water. Meals of one-dish variety minimize cleanup.



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New Mexico's Sangre de Cristo Mountains, I've considered Sierra Design's 60/40 parka the most versatile for winter treks. It has many self-sealing pockets for holding everything you need for overnight survival—extra wool socks, mittens, folding saw and knife, a cup, and some survival foods. Keeping these basic things on your person is essential when you're out in the snow.

When I found myself stranded in the blizzard, I was glad I had stuffed my pockets. After scooping out a trench with a snowshoe, I took out a folding pocket saw and sheared off enough boughs from a nearby tree for a roof, which I sealed with snow. More boughs made an insulated floor I could sit on in this crude snow cave.

Then I built a fire at the entrance and used the emergency rations in my pockets for a meal. I quickly melted enough snow in the cup for hot chocolate. A single packet of Turblokken Norwegian compressed food provided 920 calories. Afterwards I covered myself with a two-ounce Space Rescue Blanket, which also came from a pocket, and settled down to a night's sleep.

Choosing footwear. This is perhaps the most important gear for snow-trekking. The type will depend on the terrain you travel. Most hikers who climb above the timberline prefer heavy cleated Vibram-soled hiker boots, using nylon gaiters to keep snow out of them. Crampons help give better footholds on ice. Other outdoorsmen prefer hunting boots or pacs. These are worn with two pairs of woolen socks, and it's important to carry an extra change.

Picking a snowshoe also depends on terrain, but most winter hikers use the same type for all their travels. For long hauls with big packs on soft snow, 10-by-58-inch Trail Shoes with turned-up toe are superb. But after having been weaned on these long shoes, I unexpectedly found myself attached to over-wide bearpaws. The shorter bearpaws proved far more maneuverable in dense timber and thickets. My current favorite is the 10-by-36-inch Green Mountain bearpaw.

When it's necessary to walk over ice, my kit includes instep crampons. These needle-sharp points are easily strapped to boot soles or snowshoes to provide safe traction. You'll also find that using snowshoes is more enjoyable when they have trouble-free bindings.

Snowtreads, which are relatively new, can give you much the same footing. They're only 1½ pounds each, and I've carried a 50-pound pack through the Pecos Wilderness while wearing them.

Goggles and mittens. Sun goggles are absolutely essential for snow travel. Continued glare can cause snow blindness, or severe headaches. Once while I was fum-

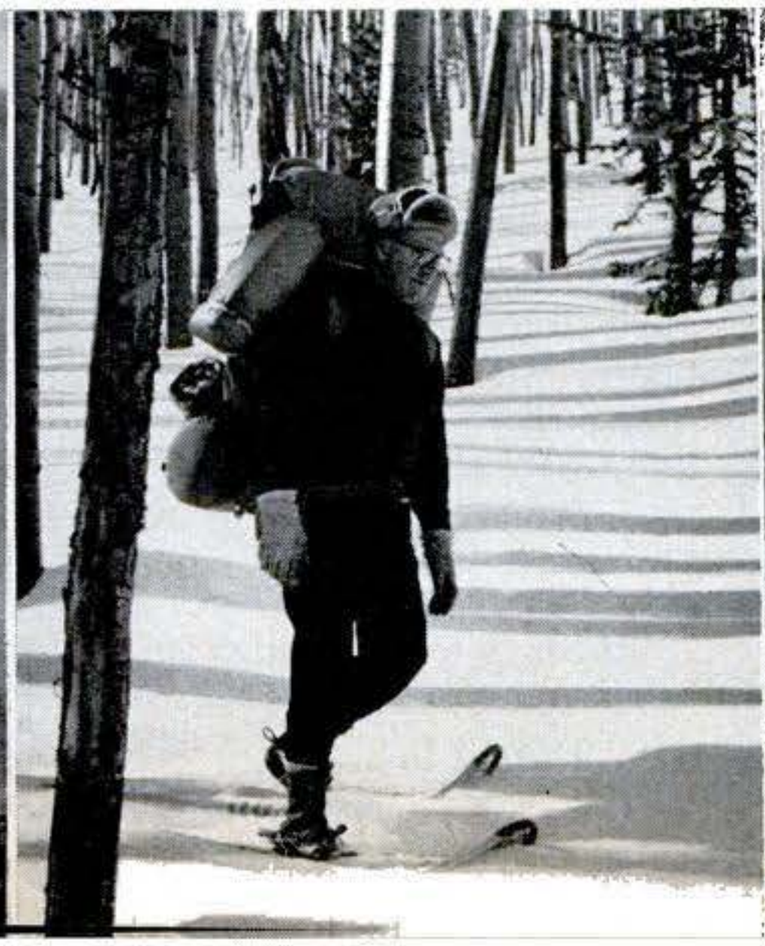
Continued

When traveling light, some campers use "elephant foot" sleeping bags, which come up to the waist, and wear parka to keep the upper torso warm. "Elephant foot" weighs a mere 26 ounces.

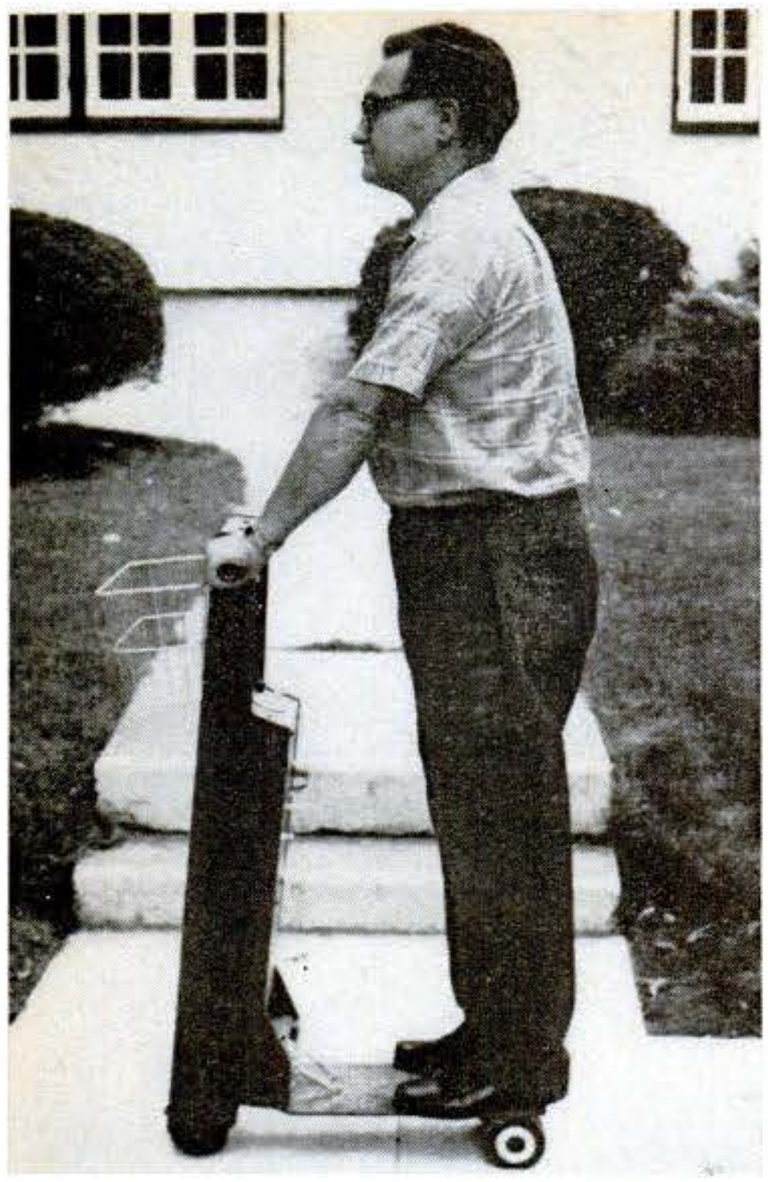
Fire-starting is made easier with Fire Ribbon, solid-fuel tablets, candles, compressed sawdust, or newspaper that has been boiled in paraffin. Waterproof matches are important, too.

Sun goggles are a must to prevent snow blindness and headaches from glare. The hooded parka and polyfoam mittens will keep you warm in sub-zero temperatures.

Snow-trekkers traveling long distances with heavy loads prefer turned-up-toe snowshoes. Bearpaws, without these toes, are more maneuverable in thick timber.



The complete snow-trekker carries everything he needs for comfort in zero temperatures. Polyfoam mukluks—nearly weightless—warm feet. Shovel aids camp building.



Travelectric has 12-volt battery, 4/10-hp motor. Circuit breaks if you crash.

PERSONAL-USE REPORT

Easy Ridin' on an Electric Scooter

Would you believe a 56-pound, fold-up, pollution-free electric scooter (with built-in battery charger) that'll go four miles on one "tank"?

No? Neither did I, so I took a ride on the Travelectric. At $395, I thought it would be an expensive toy. It's anything but. It faithfully performed—around the block, through the park, and in a furniture factory with "winding roads." When I ran out of juice, I just plugged it in.

It has two speeds: low (three mph) and high (six mph). I actually climbed fairly steep hills in high.

Two small gripes: The wheels are a little small, and the platform's too narrow. Comes with removable seat and tote basket. James Research Co., Glen Cove, N.Y. 11542.—*Doug Garr*

Instrument panel features battery gauge, charge lamp, circuit-breaker set, and fuse.

Strap On Your Snowshoes and Backpack

[*Continued*]

bling with cold fingers to change film on a high mountain pass, strong winds swept my goggles and a glove into oblivion. Since then, I've always carried extras. And taking a lesson from the Eskimo, my mittens are always connected to a cord suspended from the neck. I use elbow-length polyfoam mittens made by Ocate.

Choosing and using a tent. Camping out in the snow requires owning a good, easy-to-set-up tent. When properly pitched, today's lightweight tents provide surprisingly snug shelters that resist wintry winds. Here's how to put one up that will keep you warm and comfortable.

Stamp the area to compress snow where you plan to place the tent. Lash four saplings together to surround the tent at floor level and provide a firm support on all sides. Shafts of timber driven into the snow diagonally at each corner provide additional anchorage. If the winds are really strong, it may also be advisable to bank with snow.

Tents designed specifically for use in snow usually have aluminum poles on A frames that fit into grommets at floor level to prevent their sinking into the snow. The upper walls of tents are made of breathable nylon, and the fly is made of coated nylon to protect against wet snow and strong winds. Some snow tents have vestibules at one end for storing packs.

Mountain tents made by Gerry, North Face, Alp Design, and Sierra Design have a zippered entrance in one end and a tunnel in the other. Pitched end to end, the tunnels connect to permit free passage of occupants. They also have waterproof floors with zippered cook holes that permit you to cook inside without danger of spilling food on the floor. Of course, tents should be adequately ventilated when stoves are used. There are sleeve ventilators in these mountain tents.

Sleeping bags. To sleep comfortably in really cold weather, good ones are a must. Here again, the finest are made of nylon filled with down. You'll also need a polyfoam mattress or Ensolite pad for insulation beneath the bag. When down is pressed flat against an ice-cold tent floor it doesn't insulate. Air mattresses used in summer are cold when used on snow.

For really light traveling, I use an Ocate Venture I tent—barely three pounds in weight. And I substitute a North Face "elephant foot" sleeper that comes just above the waist and weighs a mere 26 ounces. My big hooded down parka serves as the upper portion of the sleeping bag. But this combination isn't nearly as comfortable as a full sleeping bag.

I've made some tests with the new polyfoam sleepers that are being used increasingly. One night when the temperature was 15 below, my Ocate sleeper slid outside a snow cave and, without knowing it, I slept comfortably under a blanket of fresh snow.

Some friends of mine don't believe in tents. They use a carpenter saw to cut snow blocks, which are fashioned into igloos or snow caves. These are surprisingly warm shelters in the snow.

Take a good compact stove. Here's another must for winter camping. Oldtimers traveled without stoves, but when winds are real strong, or for cooking above the timberline, they're invaluable. Besides cooking your food, they're great for melting snow into drinking water. Some winter campers mistakenly allow themselves to get dehydrated. Make sure you melt enough snow for adequate drinking water.

For starting other fires, there are many methods. One of the simplest ways is with a Mautz Fire Ribbon. It is squeezed out of a tube and burns intensely at the touch of a match. Candles or solid-fuel tablets are better than matches alone for starting fires. Some campers boil small rolls of newspaper in paraffin to produce easy-to-light torches.

What do you eat? Weekend outings offer no great weight-carrying problems, so you can bring along steaks, French fries, and other delicacies. But for lengthy trips, careful menu-planning is a must. The lightweight freeze-dried foods put out by Wilson, Armour, Richmoor, Trail Chef, and Chuck Wagon are some of the best. Choose items that provide energy and body warmth. And stick with one-dish meals that conserve fuel and simplify dishwashing.

For breakfast use Tang or other fruit drinks served hot. Instant chocolate provides more warmth than coffee. Prepackaged instant oatmeal, Bacon Bar, or other cereal breakfast gives you all you need for energy.

Precooked bacon, beef bars, dried beef jerky, nuts, cheeses, and fruits are excellent for munching on the trail. Freeze-dried steaks and chops, or dried one-dish meals mixed with water, provide quick, filling dinners.

With this kind of equipment and food at your disposal, you'll be living, not merely surviving. Winter campouts will challenge your ingenuity, whether you're a trail-hardened pro or a tenderfoot, and provide you with memorable outdoor experiences. PS

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[Continued from page 87]

camera. The design does away with the traditional, hefty penta-prism by using a mirror-folded light path. The lens, four mirrors, and an eyepiece took years of computer calculation.

Light enters the SX-70 through a glass four-element lens made for Polaroid by Corning Glass. It is remarkably short—0.4 inch from front to back—to keep the camera thin when folded. Yet it has a focal length of 4.6 inches and focuses down to 10.2 inches to give 1:2 magnification (five inches with a close-up accessory). The secret: the front element moves back and forth (less than ¼ inch) to focus. A two-bladed electronic shutter lies between third and fourth elements.

In the camera's reflex viewing mode, light then travels to a fixed flat viewing mirror made of aluminized glass, against the camera's slant back. The mirror is a trapezoid—wider at the bottom than at the top, because of its angle to the light beam focused by the lens. This mirror reflects light down to an extraordinary Fresnel surface that is actually the upper side of a carrier now in its down position.

This Fresnel serves as both focusing surface and mirror. It is a flat, aluminized plastic sheet, exactly the size of the finished picture, and lies just above the film plane. It has 200 grooves per inch; the top of each land between grooves is roughened with three tiny ripples, providing the equivalent of a ground glass. But the Fresnel is negative decentered: It gathers the light from all over its surface into a concentrated off-axis bundle and beams it off one end of the fixed mirror and out of the camera body through a hole 1/10 inch across.

The light beam now passes through two crossed metal slits (not shown in our diagrams) to correct the severe astigmatism that has been introduced by its perilous travels. It strikes another unique mirror in the viewfinder housing, a concave, aspheric aluminized plastic surface. This distorts the image like a fun-house mirror to correct for the fact that the light has hit it from below the mirror's axis, or center-line. The mirror's shape, a section of an ellipsoid, is "the wildest shape in the world," according to Dr. Land. To design it, scientists used up 2½ years of computer time.

Finally, an aerial image is formed half-way between this aspheric mirror and the magnifying eyepiece, and this is what you see.

Looking at a ray diagram of this aspheric, asymmetrical system, where the classical laws of optics seem to be violated, is enough to give a physicist the blind staggers—but it works. The correctly oriented image you see is very bright, although the lens has a maximum aperture of f/8, and it is relatively easy to focus.

You push button, we do the rest. When you push the red electric shutter button, a remarkable series of events unreels within the SX-70. It's all over in 1.5 seconds, but the sequence is so Rube Goldbergian that it takes far longer just to list what happens, much less describe it.

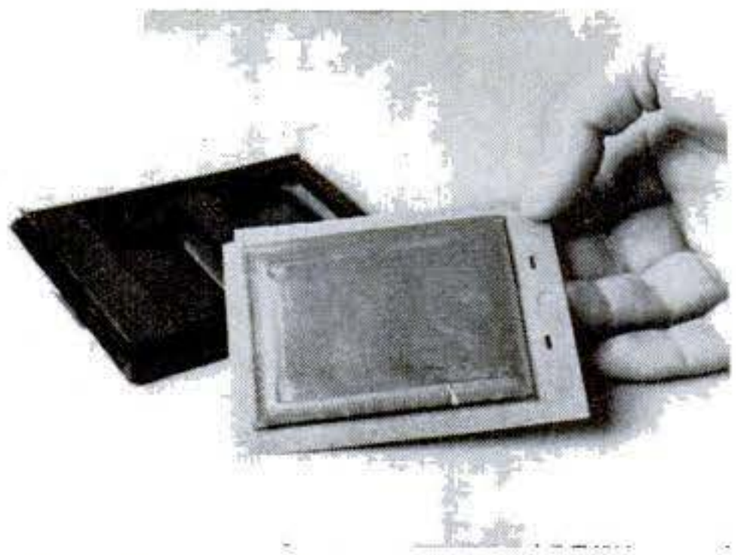
First, you switch on a solenoid that powers the motor for a burst of activity in which the shutter-diaphragm closes. The hinged carrier lifts up to take the Fresnel mirror out of the light path and unmask the film for exposure; the underside of the carrier has a flat, trapezoidal taking mirror that deflects light from the lens down to the film. Power is supplied to the ultrasensitive silicon photocell, which reads the light from the scene and signals the shutter, already opening again, to close down to the correct aperture. Logic circuits determine the combination of aperture and shutter speed: from f/8 to a pinhole f/90 and from about 1/100 second to as long as 20 seconds. They also dictate a delay of 8-10 milliseconds between the mirror coming to rest and the exposure, so that vibrations have a chance to be damped out. Then the diaphragm closes completely.

(If a FlashBar is used, the photocell does not operate; instead, exposure is determined by camera-to-subject distance as read by the focusing unit.)

Now the motor is energized again: It engages a "pick" that shoves the exposed film card toward the processing rollers; it starts the rollers turning so that the film is ejected; and it cranks the hinged carrier down to cover the new film coming up into position. When the print has passed through the rollers (it remains protruding from the front of the camera like a sassy blue-green tongue, but will be pushed off if you take another shot), logic circuits tell the solenoids to power down, the motor stops, the diaphragm opens, and the camera is in the viewing mode again.

All in 1.5 seconds! !

The chemical darkroom. How does the film develop itself in the light without fogging the grains of silver halide not previously exposed? The film card is a unique "chemical darkroom" consisting of 17 chemical layers, some only a few ten-thousandths of an inch thick, sandwiched between a tough, transparent mylar film on top and an opaque acetate backing. The processing rollers rupture a three-part



Six-volt, wafer-thin battery, here removed from empty film pack, is foil packet holding four carbon-zinc cells in layers. It must power 10 shots, has reserve for 150.

pod (at the bottom of the card) containing a mere 0.5cc of chemicals, and spread them between the lower negative layers and the upper positive layer, which will actually receive the dyes that form the image. (Any excess goo is trapped ingeniously in a cellulose strip at the other end of the film card.)

About half the content of the pod is titanium dioxide, a white pigment that will form a highly reflective background for the final image, which is in effect a transparency because it is formed on the back of the clear mylar top sheet. Together with a turquoise-colored opacifying agent—an alkali—the titanium dioxide forms a chemical curtain that protects the still-sensitive negative layers from light millions of times brighter than the original exposure.

The curtain is drawn the instant the film leaves the camera. At the same time, the development process starts, triggered by a third chemical in the pod—a developer reagent. Behind the curtain, a three-ring chemical circus is going on. Dye developers are dissolving, and those dyes that remain unoxidized are free to migrate up from the negative layers through the chemical curtain to the image-receiving positive layer, so that the color picture begins forming within seconds.

Meanwhile, in the center ring, the alkali is slowly gnawing through a resistant plastic layer called the spacer. Once on the other side, it encounters an acidic layer. And here is the key to the whole magic act: As the alkali is neutralized, the dark chemical curtain becomes completely transparent and colorless. The process acts as a chemical self-timer; when it's over, development is complete.

Unbelievable. Spectacular. And revolutionary. But will his new marvel become, in Dr. Land's words, "as widely used as the telephone"? The answer rests with you. PS

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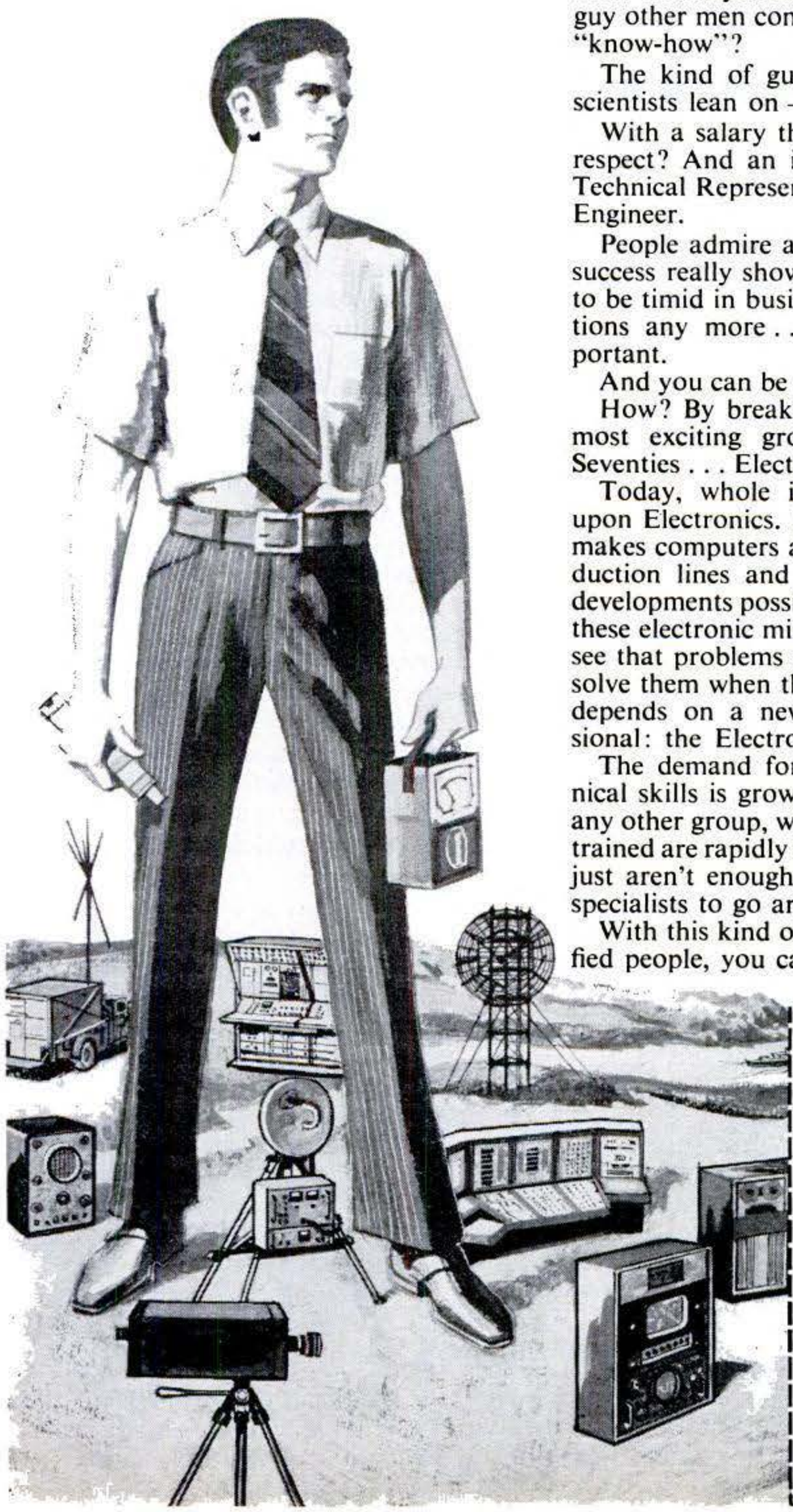
You're a pretty important guy

...when you know Electronics. And now you can learn enough to break into this exciting field right at home in your spare time.



How would you like to be the kind of guy other men come to for advice and "know-how"?

The kind of guy businessmen and scientists lean on — and listen to?

With a salary that can bring a guy respect? And an impressive title like Technical Representative or Customer Engineer.

People admire a man like that. His success really shows. He doesn't have to be timid in business or social situations any more . . . because he's important.

And you can be that man!

How? By breaking into one of the most exciting growth fields of the Seventies . . . Electronics.

Today, whole industries are built upon Electronics. It's Electronics that makes computers and automated production lines and modern aerospace developments possible. And to keep all these electronic miracles running — to see that problems don't occur, and to solve them when they do — the world depends on a new breed of professional: the Electronics specialist.

The demand for people with technical skills is growing **twice as fast** as any other group, while jobs for the untrained are rapidly disappearing. There just aren't enough trained electronics specialists to go around.

With this kind of demand for qualified people, you can earn the kind of salary you've always dreamed about. Once you have some experience, you can make $12,000 a year or more . . . but beyond tangible rewards, is the satisfaction of working in interesting and vital new fields.

You might think you need college to break into this great field. But you don't. You don't even have to leave home to go to technical school.

The Cleveland Institute of Electronics can teach you all you need to know, at home, in your spare time.

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SHOP TALK

By A. J. HAND

Stained-glass supply catalog—complete and fun to read

Are you into stained glass? Then you should know about a mail-order super-source for stained-glass supplies. They've got every type and shade of glass under the sun, a variety of lead came, tools, and a big assortment of specialty items. Whether your bag is windows, pendants, or lamp shades, these people have what you want. You can get their catalog for 30 cents by writing Whittemore-Durgin, Box 2065, Hanover, Mass. 02339. The catalog, by the way, makes better reading than Whole Earth. It's full of irrelevant illustrations such as the one of a human head captioned: "Cutaway view showing parts of brain used in doing stained-glass work. The Presidential Council on Physical Fitness says that exercise of these areas is beneficial to mental health."

More on those super bits for routers

We didn't mean to imply in our September story on Stanley's new line of carbide-tipped router bits that they've got the super-bit market all to themselves. Black & Decker offers a complete line of carbide bits, and 48 bits with ball-bearing guides in its professional products line. Their home-products accessory line includes 18 carbide-tippers, all available to you through your hardware store.

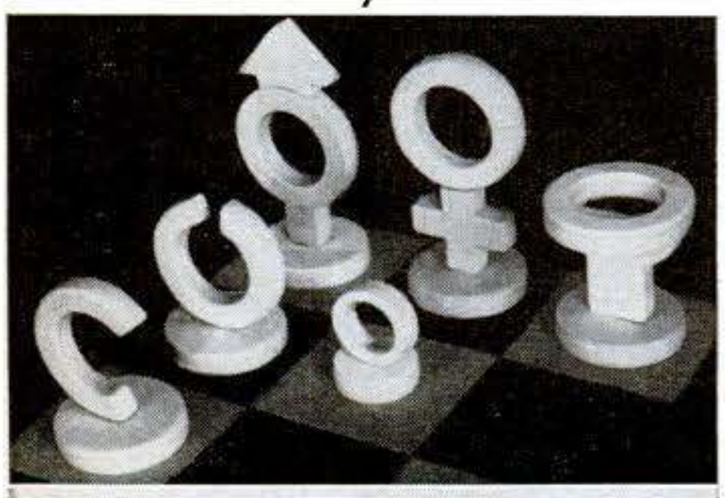
Plans for a pair of air-drive vehicles

Those of you who like to travel the back country in unconventional style will be interested in a Florida outfit called Palmer Aerosystems. They sell two well-thought-out plans sets—one for an Everglades-type airboat, the other for a two-man hovercraft. Both designs emphasize economy, simplicity, and quiet operation. No welding is required, but you will have to do some brazing. Plans and instructions are $5 for the airboat, $6 for the hovercraft. Palmer Aerosystems, Box 1891, Coral Gables, Fla. 33134. Builder's kits are available.

Ideas, plans, and catalogs to write for

Good ideas in paneling come in Wally Bruner's Guide to Wall Paneling, a new booklet from U.S. Plywood. The ideas come in the form of actual room settings photographed in color, plus a special section on tools and techniques for doing your own installation. The guide is 50 cents from U.S. Plywood, Box 61, Dept. PS-1, New York, N.Y. 10046 . . . A dime sent to Marketing Services Department, United-DeSoto, 3101 S. Kedzie Ave., Chicago 60623, gets you the booklet called Discover What a Smart Interior Decorator You Are with Today's Wallcoverings . . . Need help improving your bathroom? Check out the Borg-Warner Bathroom Planning Guide. It's half-a-dollar from Planning Guide, Borg-Warner Plumbing Products, 201 E. 5th St., Mansfield, Ohio 44902 . . . Unusual high-quality tools are the specialty of the Brookstone Co. Their catalogs come out on a quarterly basis. For a year's subscription send 50 cents to Brookstone Co., 338OR Brookstone Bldg., Peterborough, N.H. 03458.

Two novel ways to make the king and his court



What's your shop specialty—wood or metal? Either way, we've got a chess set for you to make. John P. Reid, a PS contributor from Cinnaminson, N.J., sent us the wooden version. He made it in pine, using hole saws for most of the work. Seems to me it might be fun to make in black-and-white Plexiglas as well as wood. Surrounding the pawn from left to right are the knight, bishop, king, queen, and rook. The metalworker's set comes from Al Carrell, the syndicated "Super Handyman" columnist. You can put this one together without tools—just thread together assorted pieces of hardware. This lineup reads queen, king, bishop, knight, rook, pawn. Combine these men with a magnetic board for an ideal set for travelers. PS

How to Maintain a Humidifier

[Continued from page 94]

ity). Atomizing humidifiers often turn on with the furnace and off with the burner or gas valve of the furnace.

If your furnace or heating system is equipped with central air conditioning, the humidifier should be shut off when the air conditioner is in use. On hot, muggy summer days you're more interested in removing moisture.

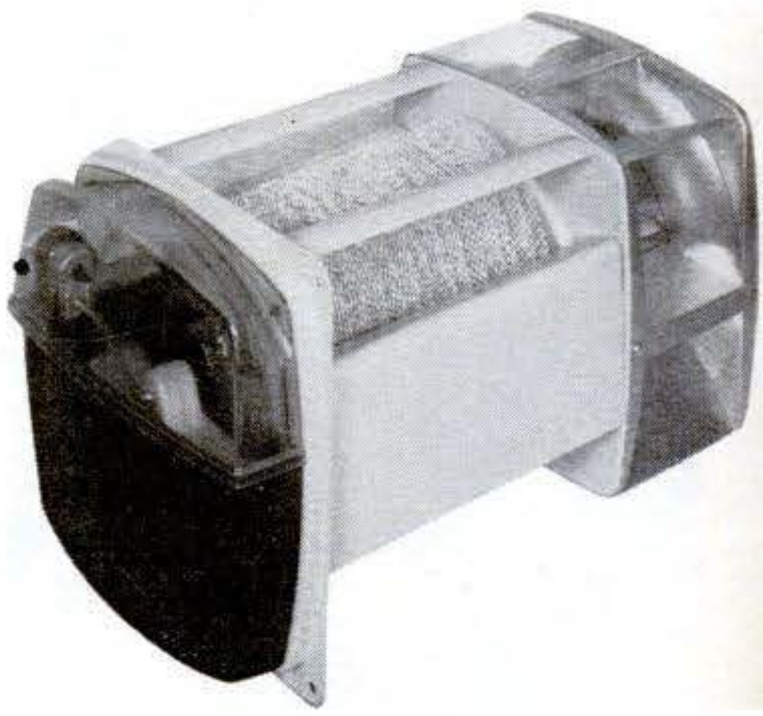
Preventive maintenance. A regularly scheduled checkup increases your chances of trouble-free operation. Most manufacturers recommend inspection every four weeks. Water conditions play a large part in frequency of cleaning. If hardness is severe, you need frequent checkups.

Check and clean the unit at least once a year. It's good practice to clean the reservoir at the end of each season and shut off water and power supply for the summer. Next winter you're off to a clean start.

Be sure that all power to the heating system and humidifier is turned off before beginning your checkup. Turn off the water. Then, remove the cover from the unit. Wash all parts thoroughly with the manufacturer's recommended cleaning chemical or a 50-percent mixture of water and white vinegar. Check nozzles, pumps, screens, and filters for deposits.

Wash the evaporative belt or pad thoroughly in the vinegar solution, rinse thoroughly (don't squeeze), and allow to drain. If the belt has stretched and doesn't fit its rollers or wheels snugly, it's time to replace it. Rollers and fans should operate smoothly—lubricate slightly if necessary. Be sure that float valves are operating smoothly and that the button completely seals the orifice when the float is raised.

When reassembling, be sure all rotating parts (wheels, rollers, and fans) have sufficient clearance. PS



New humidifier is operated by air turbine. Air circulated by furnace blower turns evaporator drum. It's model 3000 by Leigh Products, Coopersville, Mich. 94904.

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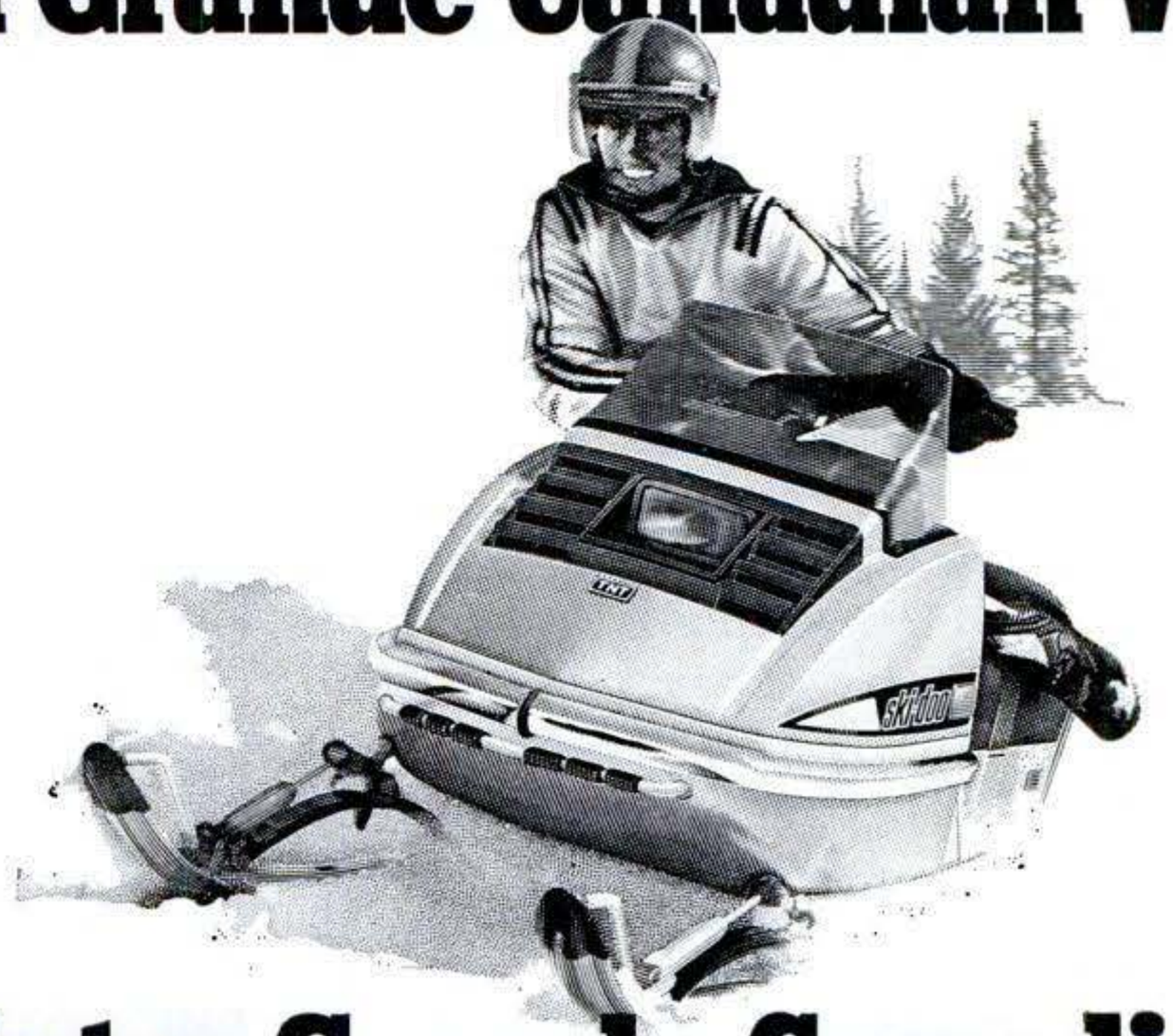
When the "500" winner crosses the finish line, you could be the winner of a Ski-Doo* snowmobile from Grande Canadian Whisky.



Enter Grande Canadian's "Snowmobile '73" Sweepstakes.

The Winnipeg-to-St. Paul "500" is no mere snowmobile race. Running four days, January 23-26, it's a flat-out overland torture test. Last year, only 47 out of 302 entrants even finished the 500-mile ordeal!

But somebody's got to win it. And if you make one of the *two* closest guesses to the official winning time, you'll win a T'NT Silver Bullet 294cc. There are also 248 other snowmobiling prizes. Grande Canadian will have its own 2-man racing team in there too, skippered by veteran Ray Beck. Start guessing. Enter now!

Follow these clues to help you win. Last year's winning time was 13:25:57 by a Ski-Doo. Slowest time among the finishers was 21:06:13. Engine size has been reduced from 400cc to 300cc for safety considerations.

250 PRIZES IN ALL

2—1st Prizes: Ski-Doo T'NT Silver Bullets
2—2nd Prizes: Ski-Doo Snowmobile suits for the whole family
3—3rd Prizes: Ski-Doo jackets
10—4th Prizes: Ski-Doo helmets
233—5th Prizes: Ski-Doo goggles

How To Enter:

1. On the entry blank below print your name, address, zip code and your guess of the winning time of the '73 International "500." Extra entry blanks are at your local package goods store.

2. Entry must be postmarked by January 23, 1973, and received by January 26, 1973.
3. Prizes will be awarded on the basis of the 250 closest guesses to the official winning time of the '73 International "500." In case of ties, winners will be selected in random drawing—first entry drawn wins first prize, etc.
4. Winners will be determined by H. Olsen & Company, an independent judging organization whose decisions are final. Winners will be notified by mail, one prize per family. All prizes will be awarded.
5. Sweepstakes open to residents of the United States, at least 21 years of age, except employees (and their families) of Schenley Industries, Inc., their advertising agencies and judging organizations.
6. Taxes on prizes are the responsibility of the winners.

Official Entry—Grande Canadian's "Snowmobile '73" Sweepstakes

Write the winning time of the '73 St. Paul Winter Carnival International "500" Snowmobile Race in this box:

hrs. min. sec.

Name_____

Street_____

City_____ State_____ Zip_____

Offer void wherever prohibited, taxed or restricted by law. No substitutions for prizes as offered.

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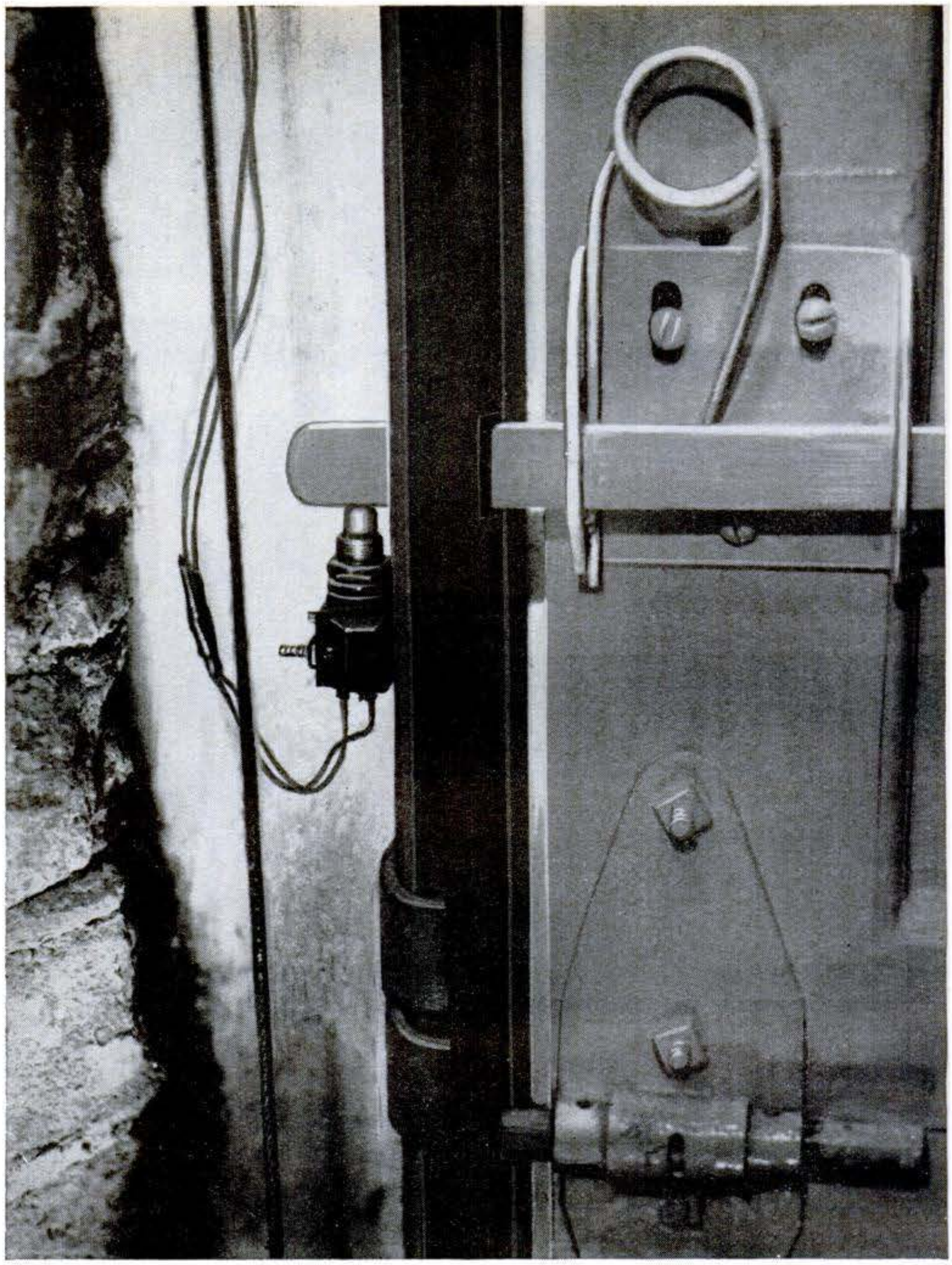
Taking Care of Your Car

Good hints others have used

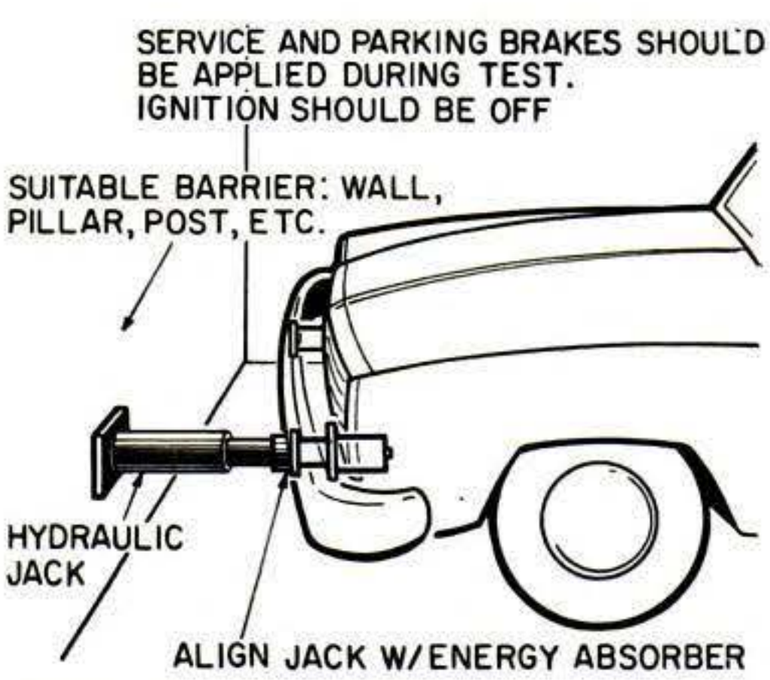
Got a car tip? We pay $25 for each one accepted. Send it to Car Care, Popular Science, 355 Lexington Ave., New York, N.Y. 10017. None are returnable.

If you don't have a workbench for automotive maintenance, and you don't have space in your garage to install one, you can convert any flat-bed trailer. Just weld a short piece of telescoping tubing to each corner, with pin adjustments for leveling.



Did you lock your garage door? You can know for sure without walking outside to check. Mount a limit switch on the guide track of the door rollers so that the switch's contacts close when the locking bar is removed. Attach bell-wire leads from the switch to a nearby transformer and then to a small indicator light in the kitchen. Then, if the door's unlocked, the indicator light will tell you so. It's a dependable security measure as well as a convenience you'll be grateful for at night and when it's cold outside.

Don't throw away "empty" oil cans—save what's still inside. To get all the oil out, cut the top from one can and attach a metal strip, bent as shown. Then let each "empty" drain for a day into the base can. You can keep a small oil gun full this way.



Impact-resistant bumpers with telescoping shock-absorbing units can be checked with a hydraulic jack as shown above. Compress each shock absorber at least 3/8", then relieve the pressure. If the bumper returns to its normal position, it's okay.

Hard-to-remove dirt from the wheels and wheel-well areas is easier to conquer with a brush. No need to buy an extra, though. The one you use to clean your toilet bowl works very well. When you're done, clean it and it's ready for use in the bathroom.

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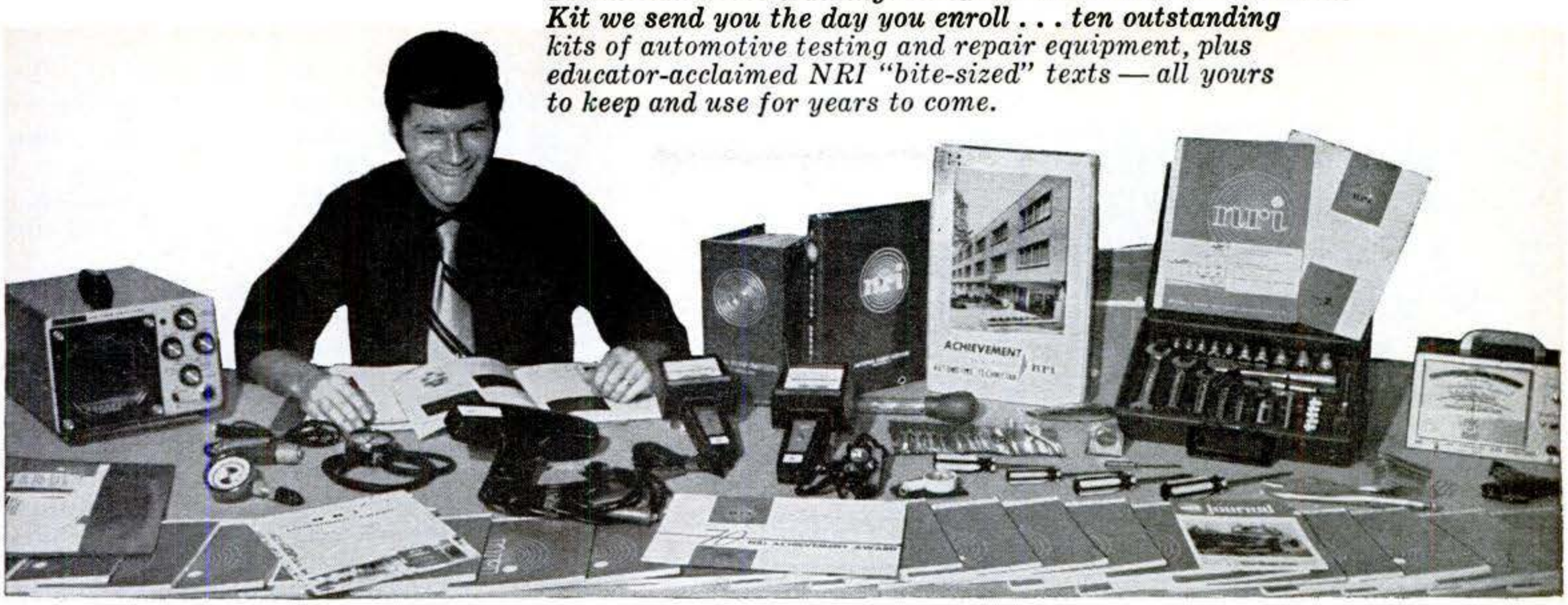

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NRI announces a dramatic new way to learn Automotive Repair at home

Top auto experts praise NRI's new training plans

NRI's two new home training programs in Automotive Servicing and Repair have been acclaimed by three of America's foremost automotive experts. Richard Petty, America's winningest stock car racer says, "I especially like the way NRI has programmed essential training equipment they give you into step-by-step instruction." Tom McCahill, car tester and writer, commented, "The Master Automotive Technician course gives ambitious guys a great start on a top dollar career. And that Tune-Up and Electrical Systems program can save do-it-yourselfers a bundle." William H. G. France, president of NASCAR reported, "The new NRI courses for mechanics are amazingly complete and seem to cover all major aspects of today's sophisticated cars. If you're at all interested in automotive training, I suggest you investigate NRI."

Professional equipment included at no extra cost

NRI gives you the choice of Master Automotive Technician training or a shorter Automotive Tune-Up and Electrical Systems course for the man seeking greater understanding of basic car repair. The Master course covers every major aspect of auto repair, from changing spark plugs to operating your own garage or car-care center. You not only learn the how and why with NRI's proved-in-use "bite-sized" texts, but you also get professional training equipment you need to actually do the work on your own or other cars as you move along in your home training. Equipment you get—at no extra cost—includes your own ignition-analyzer scope, as well as a dwell-tachometer, timing light, complete set of tools, volt-amp tester and assorted gauges. You get ten kits in the Master Automotive Technician course, eight with the shorter Automotive Tune-Up and Electrical Systems Training program. The professional tools and equipment you get from NRI are yours to keep and use in the years to come, as you build a top-pay career as a Master Mechanic, or earn $5 to $7 an hour in spare time, or simply save money by repairing your own cars at home.

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The same pioneering home training methods and innovations which have made NRI the leader in other career training fields are now offered to ambitious men who want to turn their interest in cars into a solid, well-paying career. Take a tip from Richard Petty, Tom McCahill and Bill France, and train at home with the leader. Rush coupon now for free NRI Automotive Catalog. NRI, 3939 Wisconsin, Washington, D.C. 20016. NO SALEMAN WILL CALL.

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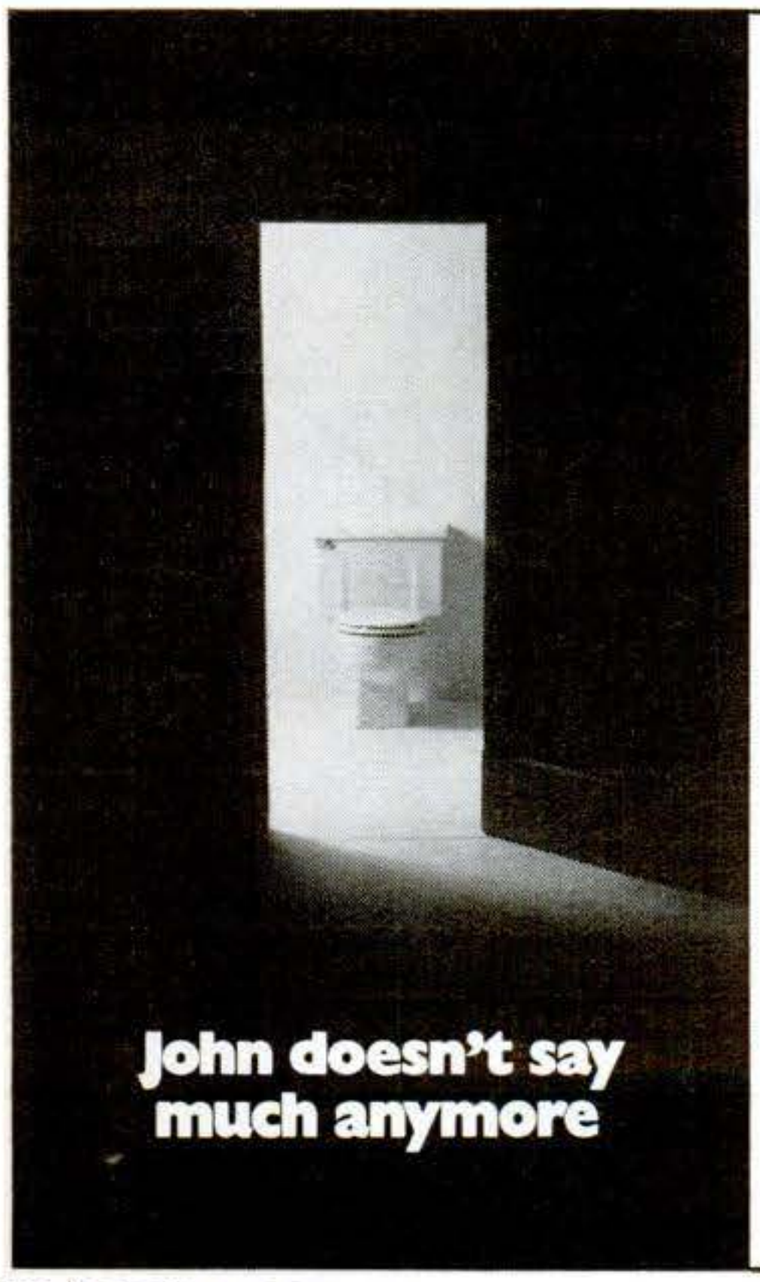

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Can Autogyro Come Back?

[Continued from page 56]

a small turbine, but this is still prohibitively expensive. As interim power for the two-seater, a 200-hp engine instead of the present 180 would make a big improvement in performance, particularly on very hot days at higher elevations.

Both planes fly with less rotor vibration than a helicopter. The McCulloch uses the same 26-foot-diameter blades used in the Hughes copter. The 18A has bigger, slower-turning blades with a bigger diameter—35 feet—and lighter disk loading. This results in two things: The 18A can land and take off slower and climb out at a steeper angle. But the McCulloch cruises at about 100 mph, about 10 mph faster than the 18A.

New blades coming. Work is progressing on a new set of rotor blades that will be stronger, have better shape retention than the present wooden blades, and last longer.

The new blades designed by the TM Development Co., which has done test work for Boeing Vertol helicopters, are foam-filled plastic with oriented linear filaments. The blade has a solid-fiberglass filament spar that is protected by a stainless-steel sheet, which forms the leading edge.

The original blades have a small trim tab on each that must be manually adjusted to make the blades track well. The new blades are supposed to be so identically formed that they will not need trim adjustment.

Looking ahead. Don Farrington and John Potter of Boston (both former 18A dealers), are hoping to revive interest in the Air and Space. They agree that the original plane was overpromoted, but think the basic design is still too good to pass by. They've picked up about 15 of the original 60 aircraft made and sold in the mid-sixties. Farrington guesses about a dozen are still flying.

They are making modifications in the craft to improve handling and performance and offering them for sale at between $17,000 and $20,000, depending on condition.

While Farrington at present has no manufacturing rights for the aircraft, he is exploring the marketing of a significantly improved version. If the reception is promising, he hopes to obtain the old assets of the Air and Space Co., which include the type certificates for the basic design. Firm price for a new one would depend on how many were sold.

Whether or not they'll be successful remains to be seen. But if they are, the old autogyro could give us a big lift into a new era of short-haul transportation. PS

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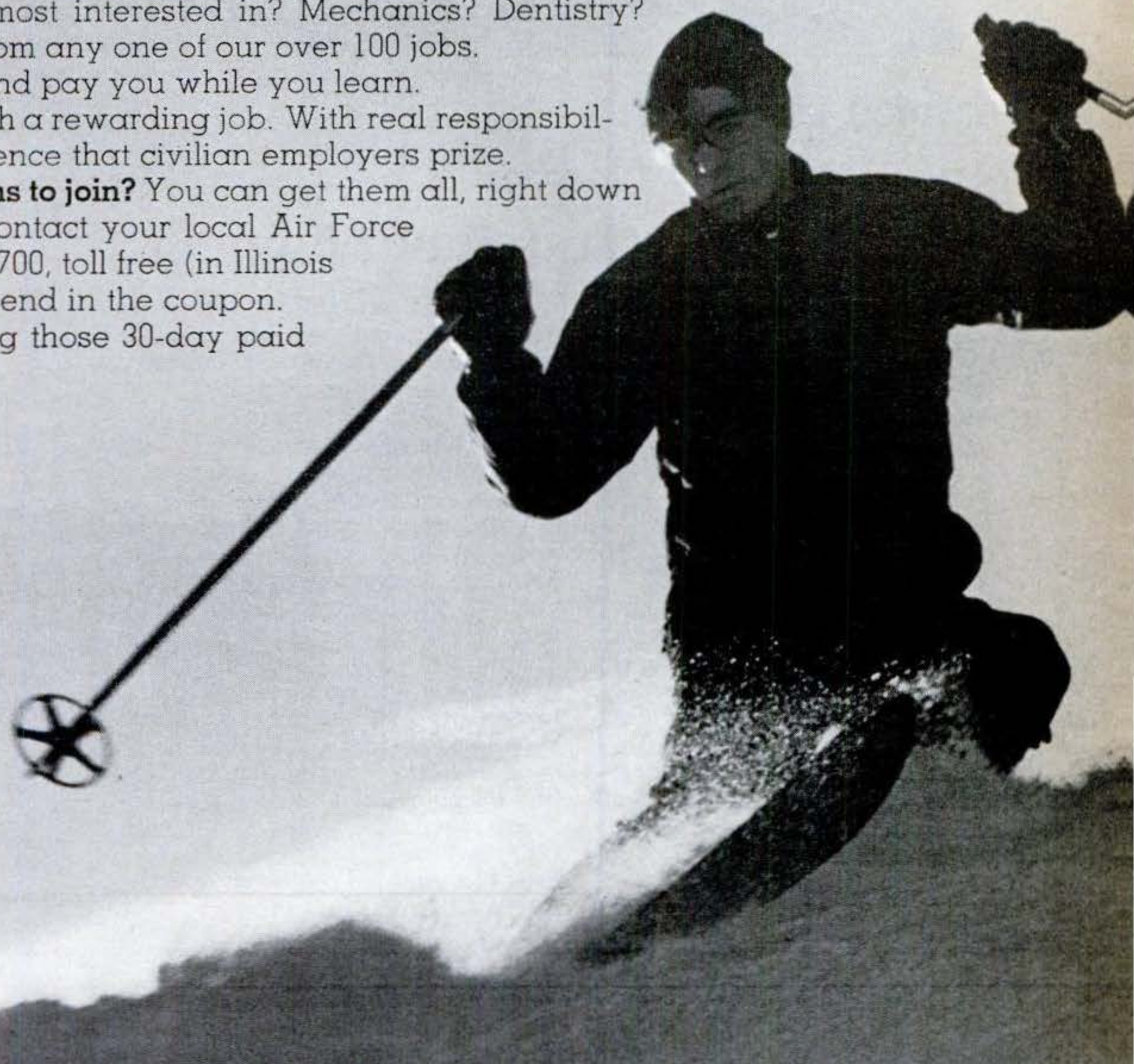

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PERSONAL-USE REPORT

Now the Pros Get an Aim-and-Shoot Camera

Is this the wave of the future?

- A completely automatic single-lens-reflex camera in which the camera selects the shutter speed after you set the lens opening?
- An electronic shutter with infinitely variable speeds, making possible, say, 1/197 second?
- A $550 price tag?

The Honeywell people, who distribute the Pentax ES, hope so.

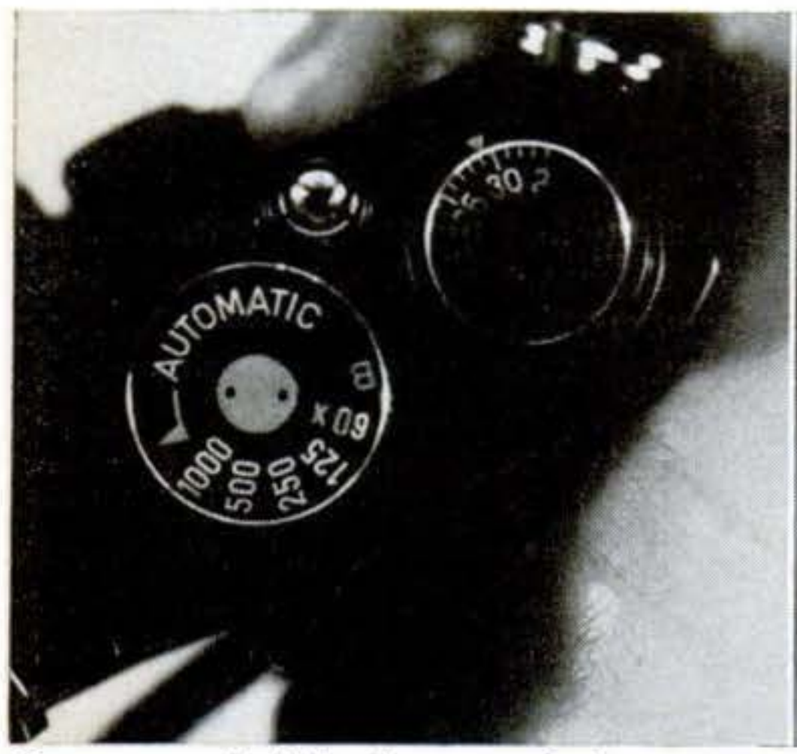
Up to now, automatic cameras have gone in a different direction: You set the shutter speed and the camera set the lens opening. In the ES way: 1) There's no need for devices built into a lens to key its aperture to the camera's machinery; 2) setting the aperture rather than the speed gives you immediate control over depth of field; 3) you have a wider range of exposure—eight to 1/1000 seconds.

You can use the ES with manual controls, like any SLR, or you can go automatic: focus and shoot. Either way, I found, the camera delivered perfectly exposed pictures.

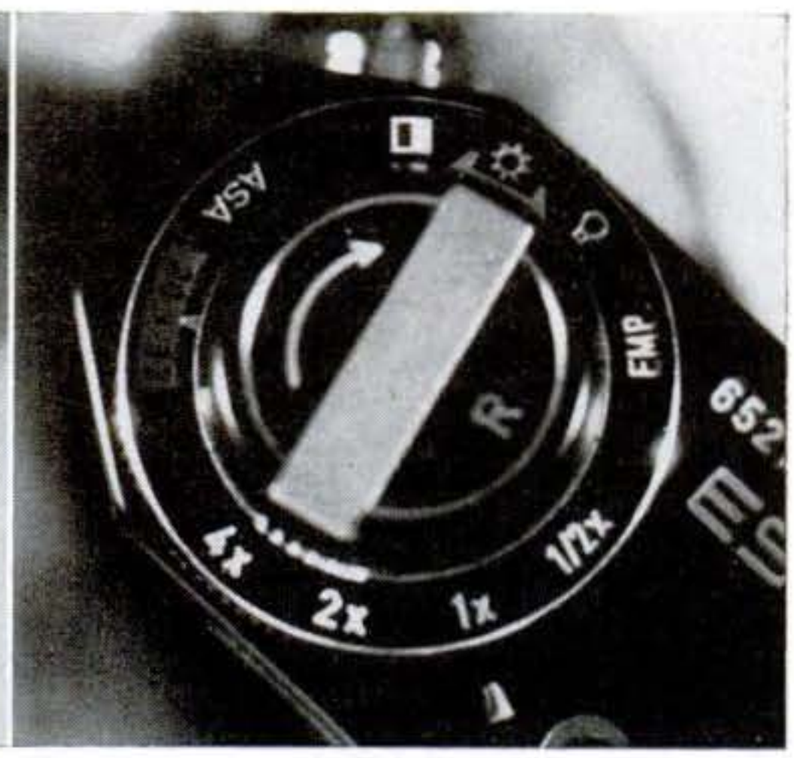
What about problem lighting—back-lit figures, for example? The ES has an answer: a dial to increase (or decrease) exposure—automatically.

Will other Pentax-thread lenses work on the new ES? Yes, but. You'll get the automatic feature, but you get full-aperture viewing only with Pentax Super-Multi-Coated Takumars.

Why would any pro or serious photographer go automatic? For special situations—shooting a football game or a motorcycle race—it's hard to beat the no-needle-to-center, aim-and-shoot capability. But $550 (with f/1.4 lens) is a high price to pay. I hope *that* isn't part of the wave of the future.—*Everett H. Ortner*



Shutter-speed dial offers speeds from 1/60 through 1/1000 second, or automatic. For speeds slower than 1/60, you use automatic mode. Film counter is at upper right.



Exposure-control dial lets you meet problem lighting situations—doubling, quadrupling, or halving exposure. Or the dial can be set between positions.

Boats You Build Yourself

[Continued from page 80]

cover. But with most of these kits it's not absolutely necessary, provided that the deck and cabin are ordered along with the hull kit.

In many cases, the deck can be elevated a few feet above the hull for installing interior components. For protection against rain and cold, the space between the hull and deck can be covered with polyethylene plastic. Or you can order the kit semi-completed—finished to the point where even this will not be needed.

On the other hand, if you build from just a bare hull, a more substantial shelter is warranted. Many builders use a temporary structure consisting of a wood frame, chicken wire, and a polyethylene plastic cover.

When you write the check. Ordering a basic hull kit for a large-size boat with or without component kits) usually involves part payment with the order and the balance before delivery is made, which will usually be from two weeks to six months from the time the order is placed, depending on the backlog of orders.

In most cases, you'll have to pay for delivery of your kit. Delivery is usually made by a low-bed truck or trailer, and most companies will help you make shipping arrangements. Usually the hull is shipped on a cradle, which you also use as the building cradle.

Shipping is expensive. In selecting a kit, remember that the closer the maker is to your area, the less you spend on delivery.

A word of caution—because getting rid of an unsuitable boat can be very expensive, make a careful appraisal of your requirements before buying. After you've decided on type, size, and design, write to the manufacturers who have kits that you think might fit your requirements and ask for their brochures.

Your next step is to order an instruction manual for your *tentative* choice. Carefully read the instruction manual and make sure you understand and can perform every step of the assembly. (A clear, lucid manual is vital!) If everything seems okay at this point, you're ready to write out a check.

When your boat arrives and you begin putting it together, take your time, follow the instruction manual to the letter, and do each job right. Before making any changes that might affect the performance or safety of the craft, consult with the kit maker.

By following these steps, you'll end up launching a safe and satisfying prefab boat. PS

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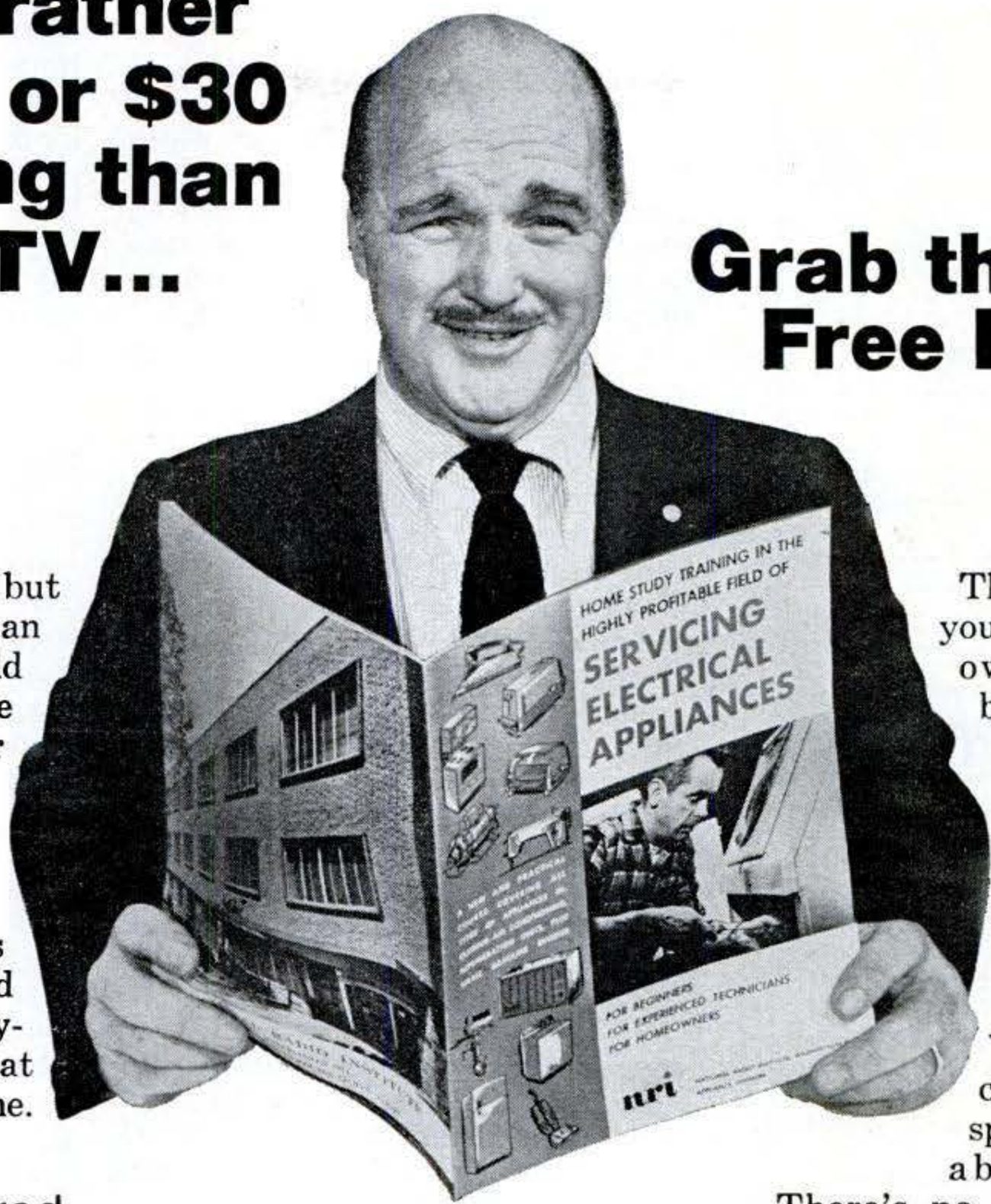

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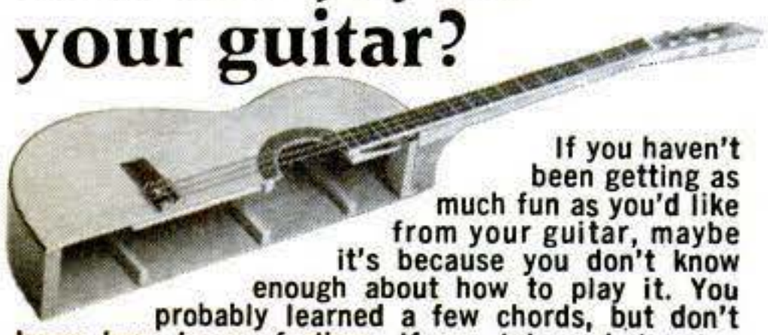

If you haven't been getting as much fun as you'd like from your guitar, maybe it's because you don't know enough about how to play it. You probably learned a few chords, but don't know how to go further. If so, let us help you. We'll teach you to read music and play pick style with both notes and chords—the way a teacher would. The difference is we teach with lessons by mail, and it costs a lot less. Courses in other instruments too—piano, spinet organ, accordion, violin, saxophone. If 17 or over, write for free booklet with more details. Send your name, address, zip code and list instrument you want to learn. Write U.S. School of Music, Studio A151, Port Washington, N.Y. 11050.

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Build Your Own Reverse-Osmosis Water Improver

[Continued from page 104]

cate low conductivity and fewer ionized impurities.

Our ohmmeter tests seemed to minimize some actual water improvements. None of our product water checked anywhere near the low conductivity of bottled "distilled" water. What Brown and Ray call *concentration polarization* may have had an effect on our test membranes. This is a build-up in concentration of raw water at the surface of the membrane, which can be caused by insufficient flow of bypass water.

We made no chemical analysis of water samples. But with their RO unit, Brown and Ray could remove 85 percent of dissolved solids in treated Lake Ontario water containing 120 parts per million of dissolved salts.

Detergent water, we found, read out higher in ohms than the pure water it was made with. Therefore, we used the amount of suds when shaken as a more reliable measure of detergent content than ohmmeter readings. Amazingly, there were no suds after RO treatment. Taste was excellent; an impressive transformation.

No ohmmeter? You can still test your product water for hardness and compare it with raw water. Just add 10 drops of liquid shampoo to equal glasses of raw and product water. Shake both and compare them.

If there are less suds in the raw-water glass, add another 10 drops of shampoo to it and shake both glasses again. If the suds in them are then equal, the product water is twice as soft as the raw water. If you must put 30 drops of shampoo into the raw water, the difference is three to one. This test shows you how much a water's hardness is changed by the process.

If you have a powerful enough microscope, you can see what reverse osmosis does for contaminated water's bacterial content.

Practical applications? Keep your RO unit uncontaminated, and you can hook it up to a basement tap and let it discharge into a large drinking-water container. Run the bypass water to a handy drain.

Reverse osmosis will separate out just about anything that makes water unfit for the highest uses—drinking, cooking, making ice cubes, preparing baby formulas, watering delicate plants, photo processing, raising tropical fish, filling batteries and irons.

Reverse osmosis gets rid of nearly any water problem, sometimes including presence of bacteria and viruses. Don't count on that, though. Microscopic damage to the membrane could cause unseen leaks that let contaminants through. It separates salt, detergent, organic matter of high molecular weight and minerals from water. Reverse osmosis will remove suspended solids as well as ionized and non-ionized solids. It will treat brackish, gypsum, and acidic waters, making them drinkable.

Can you buy one? Culligan, Lindsay, and Presto market small reverse-osmosis units that make quality water for six cents a gallon, about a tenth the cost of bottled water. Some three gallons of water a day is produced by one such unit that sells for about $200.

Because of the growing scarcity of potable water, the commercial potential of reverse osmosis is tremendous. The only energy used is that required to pressurize and pump the water. No chemicals are needed. There is no regeneration, as with water softeners, merely occasional membrane replacement. This is necessary about every other year in one unit on the market and it costs about $40 for the five-square-foot membrane.

Reverse-osmosis is so effective that the dissolved-solids content of Lake Michigan water can be reduced commercially from 170 ppm to less than eight. The brackish water of Midland, Texas, can be improved from 1300 ppm raw to 80 ppm finished. These results are at water pressures of 50 psi. Higher pressures produce even better results. Arranged in series, RO units can step up water quality in geometric progression.

For the future, scientists are working on the design of a selective RO membrane. Ideally, it would pass the more desirable ions, such as fluorides, and hold back the undesirables, such as sodium and sulfur. Some day, reverse osmosis may even permit recycling of household waste water. A great day for the environment. PS

MATERIALS NEEDED

1 2½"-dia. PVC pipe, 25" long
1 2½" PVC cap tapped on end center for ½" pipe threads and on side near end for ¼" pipe threads
1 2½" PVC-to-inside-threads adapter tapped for ¼" threads at center; internal middle shoulder cut to height of threads to allow passage of wrapped 2" PVC pipe
1 2½" PVC or brass pipe plug for above
1 2"-dia. PVC pipe, 24" long, drilled with No. 60 holes ½" apart. No holes 1" from ends
2 2" PVC plugs, threads ground off to fit into 2" pipe; one tapped for ½" pipe threads in center, other with hub or saw slot for turning
1 ¼-pint can PVC cement
1 ½" brush
3 ¼"-dia. brass nipples, 1" to 2" long
1 ¼" brass valve
1 ¼"-by-⅜" brass bushing
1 ½" brass nipple 5" long, threaded 2" one end, normally on other
1 1"-dia. worm-drive hose clamp
1 roll TFE pipe-joint tape
1 7½"-by-24" pc. 6½-oz. polyester or nylon sailcloth
2 8"-by-24" pcs. dry Eastman RO-98 reverse-osmosis membrane
1 15½"-by-22" pc. fiberglass or nylon screen
1 tube Duco cement or Sears contact cement
5 ½"-by-1¼" rubber bands
1 pressurized garden sprayer

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Flip-Top Table: Two Games in One

[Continued from page 90]

are mitered at 45 degrees, and you will note they measure 1/8" less in length and width than the inner dimensions of the sub-apron. Clearance for the cloth is needed at the ends.

After cutting the cushions to size, apply rubber cement to the upper face of the support as well as the rear of the cushions. Allow the cement to set, then press the rubber cushion firmly into place. Let the ends of the rubber overhang. The cross section of the cushion rubber is not symmetrical, so be sure to position it properly. When correctly installed, the nose of the cushion should be 1-1/32" from the bottom of the support. If *incorrectly* installed, it will measure 1 3/8".

Trim the overhanging rubber with a very sharp knife or razor. Dip the blade into water to cut the rubber cleanly. Continue the angle of the miter when trimming the rubber.

Cover the cushions with the same material purchased for the bed. Cut four strips 5" by 60", leaving the rest for the bed. Wrap the cloth around the cushion so the edges are at the rear. Staple about every inch or so, pulling the cloth taut as you staple. Start at the center and work toward the ends. Cover the miters by cementing. Apply rubber (or contact) cement to both wood and cloth. Allow to dry (it should not be tacky), then pull the cloth over the ends and gather it so excess is at the middle of the miter. Trim with razor and press loose ends firmly in place.

Making your bed. Lay out and cut the holes for the posts and liners as shown. The post holes can be made with a spade bit and portable drill. The larger holes are best cut with a saber saw. Before making the cutout for the pocket liner, cut a trial piece for fit. The liner should fit snugly with cloth in place.

The saber saw is also used to make the 1/8" notches in the post holes. The notches prevent posts from turning when tightening nuts from below.

Cover the bed with the remaining cloth. Dust off the board carefully first. Staple the cloth to the edges, working from the center. Do the long sides first, then ends.

Cross-slit the cloth for the hole cutouts, stopping just a trifle before the edge of the hole. The free ends of the slitted cloth around the pocket liner cutout should be stapled to the underside of the table. No stapling is required at other holes.

Mount the bed to the support with 1 1/2" No. 8 FH screws. Next, install the cushions, driving screws from the upper edge of the sub-apron. Sink the heads slightly.

The hockey board. Drill the holes for the deflectors and mount with the 3/4" RH screws. The board simply lies on the bed support, held in place by the frame, which is screwed to the subframe as indicated.

To eliminate painting the hardboard, we used prefinished Marlite. This material has a very hard, smooth surface ideally suited to the game. If unpainted hardboard is used, paint with a quality gloss enamel.

The pivot hardware is installed using a flat washer between the apron and hand wheel. Install the four angle brackets with FH screws so the bracket can swing out of the way without binding when you flip the table top, then swing back into position to hold the bed level. Tighten the screws all the way, then back off 1/2 turn.

The specialty items such as cushion rubber, bumpers, balls, cloth, and the pivot bushing are available from The Armor Company, ~~Box 290~~, Deer Park, N.Y. 11729. Write for a free price list. PS

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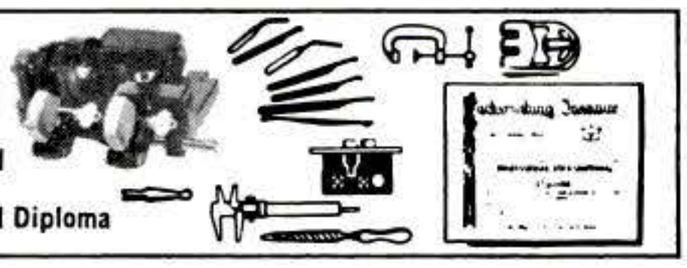

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[Continued from page 67]

there must be a vent to let this gas escape—with a catalytic burner for its safe disposal.

What looks like the most promising answer yet comes from a research team at Brookhaven National Laboratory—a fuel canister of hydrogen-bearing metal powder.

Numerous metals and alloys absorb prodigious quantities of hydrogen by forming compounds with it, called hydrides. Some give up the hydrogen on being heated—for example, magnesium-nickel hydride, at about 500 degrees F. Others, like iron-titanium hydride, spontaneously give off hydrogen and need no heating.

For a hydrogen car, the Brookhaven group proposes a main fuel tank of the first type of hydride, heated on the road by the car's exhaust to generate the fuel supply. Hydrogen for start-up would come from a small auxiliary tank of the other kind of hydride, which could then be replenished with hydrogen from the main tank's output. The main tank could be recharged with hydrogen at a future service station; it would take only a few minutes' time.

A service station could make hydrogen right on the spot. The installation needn't be a big deal. A commercially available "packaged" electrolytic-hydrogen plant turning out a modest 400 cubic feet hourly would do, a leading maker of such equipment told POPULAR SCIENCE.

Engines for hydrogen cars. Piston engines designed for gasoline don't take kindly to exotic hydrogen's burning characteristics. They knock, and backfire through the carburetor. But ways have been found to counter this —perhaps the oddest way, recirculating part of the exhaust through the engine, as the UCLA team did.

Now Oklahoma State University researchers have produced an engine specially designed for hydrogen. A patent for it was granted in 1971 to OSU's Dr. Richard G. Murray. Trials of four single-cylinder engines, converted from commercial gasoline types to the new design, show it licks knocking and backfiring.

Only air is compressed by the piston. Much as fuel is injected in a diesel, an injector squirts hydrogen gas into the cylinder, and a spark plug instantly ignites it.

Clean hydrogen fuel can't quite break our 150 million internal-combustion engines of one dirty trick. *Not from their fuel,* but from air, comes one potential pollutant they emit: oxides of nitrogen. At the high temperature of a fiery cylinder, some atmospheric nitrogen and oxygen combine. The resulting oxides go out the exhaust, along with combustion products. In the air, NO_x acts as a catalyst, to help ultraviolet light turn unburned hydrocarbons (from fuels other than hydrogen) into smog.

But absence of the hydrocarbons will break the chain leading to smog, if hydrogen engines replace others. Until then, it's important that hydrogen engines inherently have a much lower nitrogen-oxide emission than gasoline engines do.

Impressed, the U.S. Environmental Protection Agency sponsored a 16-month test of Murray's engine by OSU's Dr. Roger J. Schoeppel, his co-worker. It showed NO_x emission reduced to one-tenth as much as from gasoline engines. Of course the exhaust contained no carbon monoxide (a would-be suicide would have a frustrating time with it) nor carbon dioxide, and none of the unpleasant hydrocarbon products that come from burning gasoline.

"A multi-cylinder engine run on hydrogen should be able to meet the 1975/76 Federal Emission Standards," Dr. Schoeppel's report to the EPA concluded.

Trials showed, too, that the OSU engine is easy to start, responds quickly to changing the rate of fuel injection, idles at half the speed possible with a gasoline engine, and runs cooler under low to intermediate loads.

Wankel likes hydrogen. The pistonless, rotary Wankel engine figures in an exciting new report from Brookhaven by experimenters R. H. Wiswall Jr. and J. J. Reilly:

"We have established that a Wankel engine will run very smoothly on hydrogen-air mixtures." And then, the sensational part: "No mechanical changes were required."

To auto makers weighing the cost of redesigning and retooling for the hydrogen car of tomorrow, a gasoline engine already suited to hydrogen would be of the utmost significance. Since they've already invested large sums in Wankel patent rights and technology, the changeover might be easier than anyone had supposed.

Another implication: the possibility of a "hybrid" Wankel car that could burn gasoline in rural areas and switch to hydrogen for cities.

Next center of attention will be early trials of an operating hydrogen-car "hydrides system" with an actual engine, "probably a Wankel," planned at Brookhaven.

Electric and steam autos offer alternate hydrogen-car possibilities. General Motors in 1966 built an experimental electric one, the Electrovan. Hydrogen-oxygen fuel cells drove its electric motor. The problem: its weight, more than twice as much as GM's conventionally powered Handivan, from which it was adapted.

A Mach-6 passenger plane. Hydrogen can power an airplane—and what a plane! NASA's idea of a hydrogen aircraft is a "Hypersonic Transport" of Mach 6 speed, enough to make today's SSTs look as if they were standing still by comparison.

Goal of NASA is a transocean passenger craft of 5000-mile range, cruising at 100,000-ft. altitude, and carrying more than 200 passengers. It's a long-range research project, but wind-tunnel tests of experimental hardware are well along.

The Hypersonic Transport would be propelled by air-breathing ramjet engines fueled with liquid hydrogen, carried in heat-insulated tanks within the fuselage of the 300-ft.-long delta-wing airplane.

Fueling up these craft of the future would take so much hydrogen that most international airports, it's foreseen, could afford to have a nuclear reactor and a hydrogen-making plant.

Hydrogen-powered aircraft needn't necessarily be as fancy as a Hypersonic Transport. "It will be perfectly feasible, and in fact advantageous, to design all new airplanes to use hydrogen," opines Laurence O. Williams, Martin Marietta chemical consultant, in *Astronautics & Aeronautics.* (As long ago as 1957, NASA's Lewis Research Center successfully flight-tested a liquid-hydrogen fuel system on one of the turbojet engines of a B-57.)

From scarcity to plenty. Technologists will solve remaining hydrogen-fuel problems, because they have to, prophets say. Current events show time is running out. Our dwindling oil is being drained all the faster because present ways to curb auto pollution demand more fuel consumption than before, for the same power output from an engine.

With our natural gas running low, we're preparing to import it from as far away as Algeria—liquefied and carried in "cryogenic" or super-refrigerated tankers.

When the world's reserves of these once-plentiful fuels are gone, it will take nature millions of years to replace them. In contrast, the natural cycle of hydrogen fuel will be a conservationist's ideal. Water from burned hydrogen enters the atmosphere, returns as rain, and within days or weeks is back in the sea from which it came—ready to yield more hydrogen for man's needs, over and over and over again. PS

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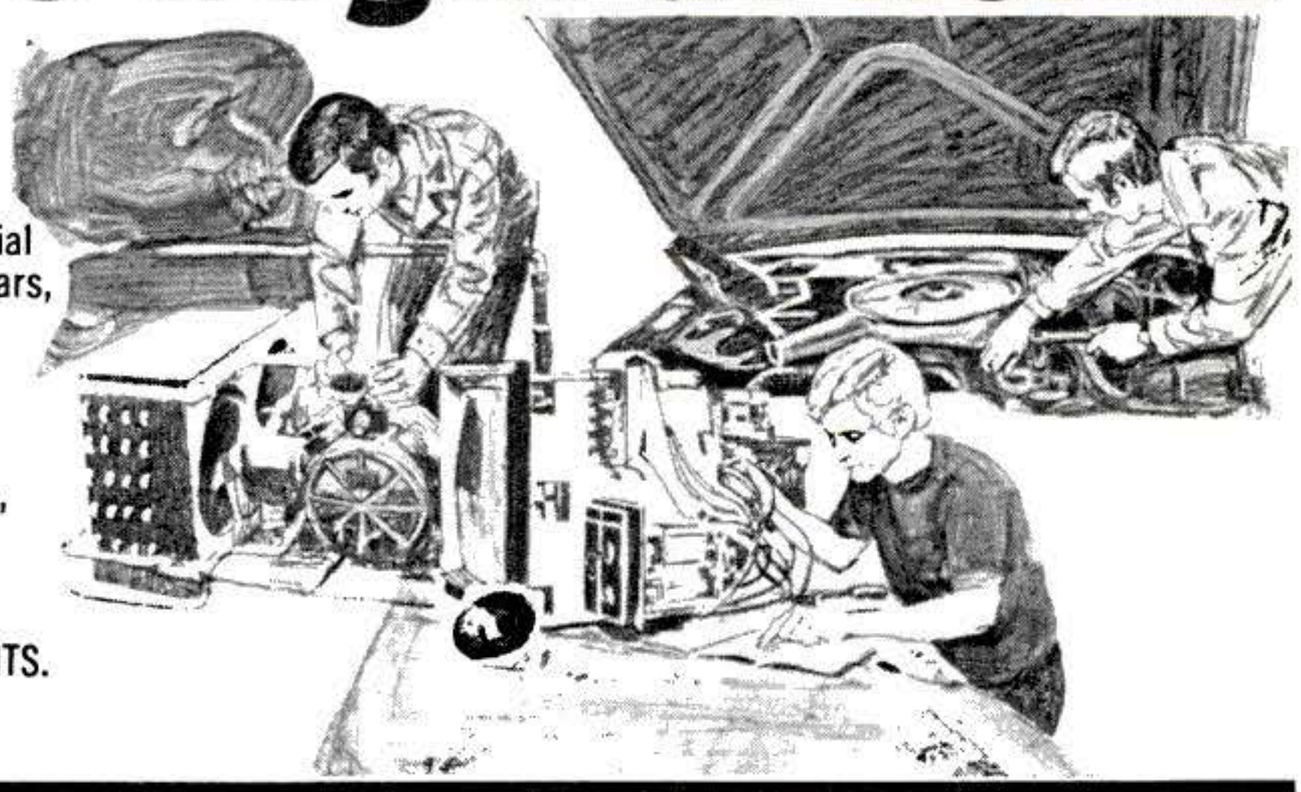

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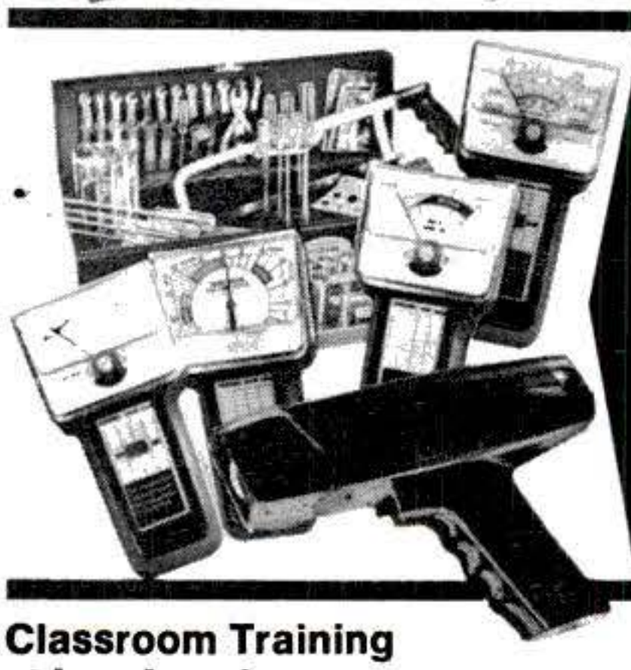

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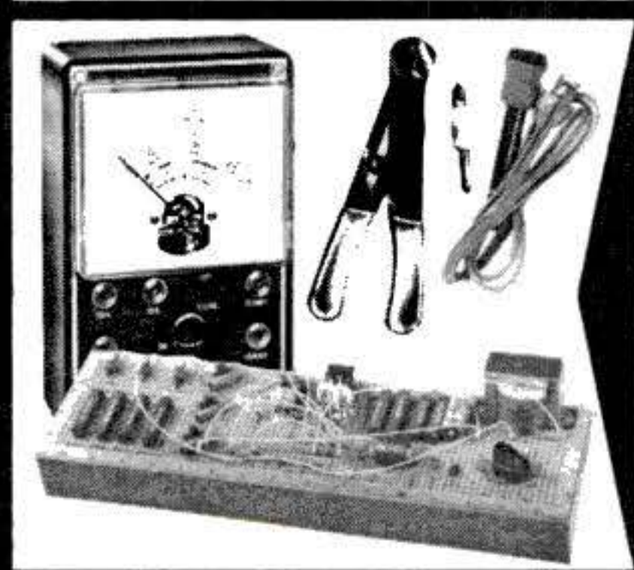

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Alaska Pipeline Plan Spins Off a Science Bonanza

[Continued from page 52]

Because no one could predict which plants, if any, might be affected directly above the pipeline, a full-scale, 600-foot section was buried in permafrost at the University of Alaska's Fairbanks campus.

Sensors fed into computers data on such areas as heat transfer and dissipation. Heated to 140 degrees, the test section accurately simulated the real pipeline. After two typical growing seasons and two severe winters, many plants have shown an ability to go dormant and revive.

Although the Biome project will continue until 1974, scientists have agreed on one preliminary conclusion: Despite its fragile nature, tundra has an amazing capacity to resist man's damage, and to recover.

Vegetation for replanting. Simultaneously, Alyeska and cooperating groups launched a worldwide hunt for plants capable of prospering in the state's varied soils. Seeds from other Arctic regions—Siberia, Finland, Canada—were tested. These would be used in replanting areas bared by construction.

To allay environmentalists' fears that extraction of gravel from wilderness streams for pipeline construction would harm fish, extensive ichthyological studies were begun.

An ardent angler, I couldn't help envying Dr. Peter McCart, a Canadian ichthyologist; for three summers, he has camped on a succession of wilderness rivers and lakes—primarily Alaska's important Sawavanirktok River—hooking lunkers with ordinary rod and reel. And he gets paid for it, too.

"Some days, I hook as many as 40 fish before lunch," he says. "And when I run out of supplies, they drop me more by helicopter."

Inventory of fish. Colleague federal and state biologists were assigned other areas of the pipeline route. What resulted was the first complete fish inventory in Alaska history.

Ichthyologists elsewhere studied their findings with fascination. For instance, Dr. McCart discovered a species of lake trout 30 years old—with a life span roughly paralleling man's. At another location, he found a species of grayling long ago fished out of waterways in the "Lower 48." He also identified, for the first time, two distinct species of Arctic char.

Using such information, scientists now have computerized baseline data on such facts as fish populations, productivity, classification, critical run times, downstream spawning areas, and periods of minimum population density.

"With this data," an Alyeska official explained, "we can time our construction activities to avoid disruption of, say, critical spawning periods. This is one reason why we'll work mostly in winter. This data helps, too, in laying the pipeline route; for gravel removal, we've now given top consideration to upland areas and braided streams to minimize siltation."

Wildlife crossings. Migration habits of Alaskan wildlife, notably the state's 400,000 caribou, have undergone similar study. To determine whether caribou will cross the pipeline (conservationists feared they would not) Alyeska built a two-mile section of four-foot fence near Prudhoe Bay, resembling the pipeline in appearance. In some places, dirt ramps were built over the mockup; at other spots, the line was elevated on trestles to allow caribou to pass underneath.

Scientists waited in blinds with cameras to record the results. Their conclusion: Caribou cross the lines, paying little heed to man's activity nearby.

To make doubly sure that the animals wouldn't be interfered with, Alyeska engineers used the impact-study data in considering routing for the line. For example in one section of the imposing Brooks Range, which an estimated 30,000 to 40,000 caribou traverse in their annual migration, the line will be buried entirely.

After a study of known breeding areas of Dall sheep in the Brooks Range, sponsored jointly by the Alaska Fish and Game Department and University of Alaska biologists, Alyeska changed its planned route to avoid disturbance.

Charting ocean currents. Another "first" in science was an oceanographic baseline study, now completed, of the virgin fjord port of Valdez, the southern pipeline terminus. Conducted by the Institute of Marine Science, University of Alaska, with oil-industry funding, the study set up 21 sample stations in the Valdez arm of Prince William Sound. Biological information was acquired and currents were measured by meters and dye-diffusion gear.

The study indicated that Valdez is a classic example of a "positive fjord estuary"; more fresh water enters the harbor through runoff than is lost by evaporation. The harbor thus renews itself at least once a year.

Environmentalists had charged that an oil spill in the harbor would cause potential danger to marine life. Without the baselines data, biologists studying such a spill would have no biological "yardstick."

"Think of what it might have meant," a biologist conjectures, "if we had this kind of information for, say, San Francisco Bay in the pre-super-tanker days of the 1800s."

The impact-study list wanders through scores of scientific disciplines and sub-disciplines. When it appeared, for instance, that construction might affect valuable archaeological sites, Alyeska supported a "dig" along the entire 800-mile pipeline route.

"Never before has anyone been able to cut a transection of an entire state," beams Michael Kennedy, curator of the Alaska State Museum in Juneau. "We're tremendously excited about it."

Early migration sites. In two years archaeologists have found 189 sites; the information is particularly significant because the Alaskan interior was a key entrance to the New World from Asia 50,000 to 60,000 years ago.

Alaskan birds were also studied; one survey counted 171 species of waterfowl alone. At Cook Inlet, a graduate student expert in seabirds is currently defining the ecology of a kittiwake colony on Chisik Island. Another ecologist is studying falcons on the North Slope, near the oil fields. Yet another learned that Alyeska had planned a communications station near a nesting site of rare peregrine falcons. Based on his information, the site was moved.

Some other results of the impact-study program:

- Seismologists determined that the pipeline route lies near four major fault zones and directly crosses a fifth, the Denali. Now, knowing this, Alyeska has agreed to establish an instrumented earthquake "warning system" along the route.

Based on data compiled by the U.S. National Center for Earthquake Research, Alyeska will install creep meters and seismometers at given intervals. These, seismologists say, are useful in detecting minor temblors which often precede major shakes. If such a major quake seems imminent, the oil flow will be shut down immediately.

- Medicine will benefit from a study of the effect of the Arctic's seasonal, 24-hour daylight on the human body.
- At Barrow, scientists are trying to learn how the Arctic fox can withstand extreme cold without harmful effect. "If we can determine this information," Dr. John Schindler, di-

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Alaska Pipeline Plan

[Continued]

rector of the Naval Arctic Research Laboratory told me, "it might be very helpful to the study of frostbite in humans."

Risks to environment. Not all the studies, of course, were financed by oil interests, and not all directly involved the pipeline. "But the oil-boom spin-off," an Anchorage businessman told me, "sure helped us learn a lot more about ourselves, and about our state."

Both Alyeska and the Interior Department acknowledge that extreme risks are involved. In its six-volume environmental-impact report last March, in fact, Interior stated: "No single oil-delivery system would be free of environmental effects or potential threats." Concedes Alyeska's Patton: "Our goal is to avoid damage where possible, hold it to a minimum where unavoidable, and restore to the fullest extent what we've touched."

Last August, after the impact study had been submitted by the Interior Department, federal judge George Hart lifted the injunction blocking construction. Apparently expecting an appeal by environmentalists, however, he said he could "confidently anticipate the final decision rests with the Supreme Court." To date, permits have not been issued for pipeline construction to begin. Alyeska remains in low gear: construction camps emptied of all but skeleton crews, production wells capped off.

Some environmentalists are pushing for adoption of a trans-Canada route that would enter the midwestern U.S. through Alberta. Such a line would be four times the length of the Alaska pipeline and about double the cost. Some Canadian officials have expressed interest in the trans-Canada proposal, but observers believe the political conflict that might result from such a project—as well as opposition from the oil companies—will prevent a Canadian line for Alaskan oil.

Overcoming hazards. Whatever further delays might occur, however, it has been suggested that the outcome already has been a victory for the environmentalists. It was Dr. Schindler, Navy Arctic lab director and a veteran biologist, who perhaps summed it up best. "What we've gained from the impact study has been massive," he told me. "I have many reservations about the pipeline, but industry technology—and environmental pressure—has overcome many hazards that loomed at first."

Considering the vast spinoff of scientific and technical know-how generated by Alaska's oil boom, it would seem that the 49th state can only come out a winner. PS

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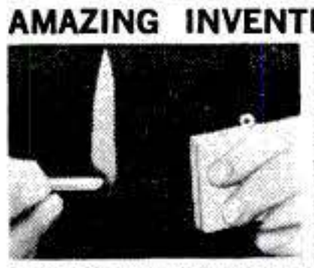

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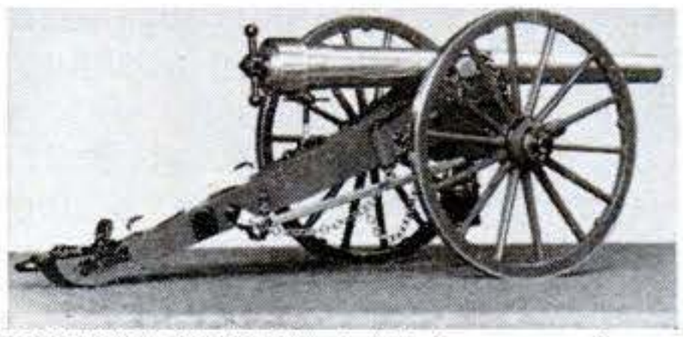
ELECTRONIC CALCULATOR with 8 digit capacity, adds, subtracts, multiplies & divides. Features chain multiplication & division. Floating decimal for figuring percentages & taxes. Plugs into any AC outlet. $84.95 + $1.50 pstg & hdlg. 10-day money-back guarantee. TEC Electronics, Dept. PS, 2001 Via del Rey, So. Pasadena, Ca. 91030.



THE WHITWORTH. A rifled cannon introduced during the Civil War & capable of greater penetration than smoothbore guns. Gun carriage made of cast metal, gun barrel is solid brass. Model 9½" L, 3½" H. Complete kit $11.95 + 75¢ shpg. Catalog of ships & cannon kits 25¢. Preston's, 96-R Main Street Wharf, Greenport, N.Y. 11944.

FIREPLACE FURNACE. Prevent most heat from escaping up the chimney by cradling your fire on the Thermograte. New C-shaped grate is welded from steel tube, draws cool air at base & pours hot air at top. Easily installed. Convert fireplace into circulating air heater. $69.50 freight pd. Thermograte Enterprises, Dept. PS, 51 Iona Ln., St. Paul, Mn. 55117.

DIGITAL SPEEDOMETER. Sporty instrument with unparalleled readability & accuracy. Shows speed to 199 mph with 1 mph accuracy. Dash-top positioning with ½" high luminous green digits. Three warning lights alert driver of high speed ranges. Complete kit $94.95. Rotiform Corp., Dept. PS, 2008 Cotner Ave., Los Angeles, Ca. 90025.

BUILD THIS UNIQUE HEATHKIT 6-DIGIT ELECTRONIC CLOCK ...$54.95

New solid-state silent timepiece with computer-logic accuracy and high-visibility illuminated electronic readout tubes tells time to the second. Reads 12 or 24 hour time on 120 or 240 volts, 50 or 60 cycles. "Beeper" alarm automatically sounds every 24 hours; repeating "snooze" switch gives extra 7 minutes sleep. Assembly manual guides you one easy step at a time to completion in 2 or 3 evenings. Black Cycolac® case with simulated walnut inserts. There's nothing like it at this low kit price.

Kit GC-1005, 4 lbs. **$54.95**

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☐ Please send FREE Heathkit Catalog.
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Address _____
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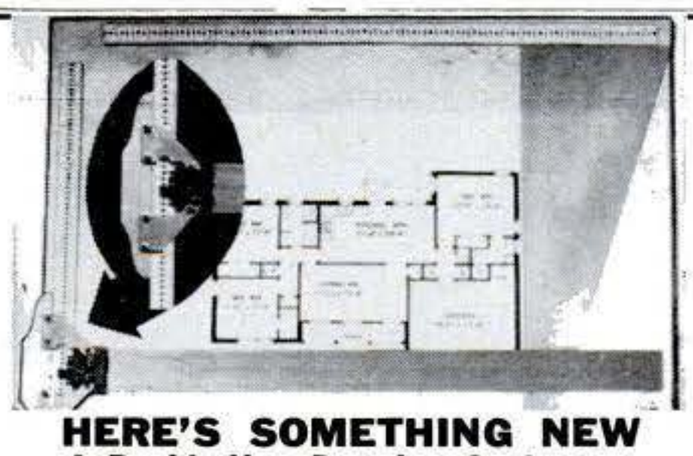

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DRAWINGS THAT DO YOU PROUD. In scale and correct proportion. Unique pushbutton system forces accuracy. Actually pulls your drawing edge to exactness. You can't go wrong. Will do enlargements and reductions too. A most discreet board if you want excellent drawings. Easy way to learn art and drafting too. Plan shop projects. Draw that new office and it's business forms, design your dream home, even to placement of furniture. Direct reading scale prevents mistakes in drawing and construction. Two sizes, 24"x24"—**$19.95** and 28"x30"—**$29.95** plus $1.85 shpg. Both have stainless steel drawing edge, plus many needed accessories and simple, but detailed instructions. Return in 2 weeks for full refund if not delighted. Send check or M.O.

J. W. HOLST, Inc. Dept. PS-1, 1005 E. Bay St. East Tawas, Mich. 48730.

WINDWATCH™ ANEMOMETER—WIND VANE $19.95

Neon lights in indoor indicator show wind speed and direction. Decorative indicator with gold dial in dark mahogany case. Designed for desk use or wall mount. Outdoor instruments of durable aluminum with electrical parts enclosed in rigid vinyl housings. Easy to assemble and install. Attach directly to roof or pole. Comes with wire and materials for installation up to 60 feet. Uses regular 120V AC. Unique low amp circuit assures absolute safety. A fascinating addition to any home. Five year guarantee. 15 day trial. Your satisfaction or money back. Only $19.95 postpaid.

WINDWATCH DEPT. L8. 104 HEIMANN SAN ANTONIO, TEXAS 78205

IT'S ALMOST LIKE PRINTING YOUR OWN MONEY!

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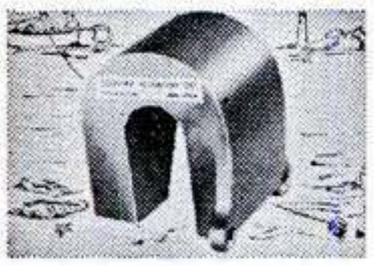
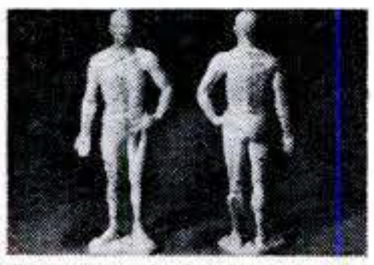
"FISH" WITH A MAGNET



Go treasure hunting on the bottom! Fascinating fun & sometimes profitable! Tie a line to our 5½-lb. Magnet—drop it overboard in bay, river, lake or ocean. Troll it along bottom — your "treasure" haul can be outboard motors, anchors, other metal valuables. 5½-lb. Magnet is war surplus—Alnico V type—Gov't cost $50. Lifts over 150 lbs. on land—greater weights under water.

Stock No. 70,571N .....**$14.00 Ppd.**
Stock No. 60,215N .....**1½ lbs.**.....**$ 5.75 Ppd.**
Stock No. 70,570N .....**3½ lbs.**.....**$ 8.75 Ppd.**
Stock No. 85,152N .....**15¾ lbs.**.....**$33.95 FOB**

AUTHENTIC ACUPUNCTURE MODEL



Learn first-hand about Asiatic needle probing from exact duplicate of models used in Red China. 10½" free-standing model clearly shows 12 all-important meridian lines and approx 500 specific points an acupuncturist must learn to pierce. Precise enough to serve as teaching aid for doctors, teachers & medical students. Fully illustr instructive 12-page bklt. See why this 5000 yr. old healing & pain removal method has had such impact on Amer. medicine. Polyethylene (rubberized).

Stock No. 71,778N ..... **$10.00 Ppd.**

PROTECTIVE SEE-THROUGH DOMES

Keep dust, moisture, air currents, insects from displays, models, products, scales, etc. Make table aquariums! These sturdy ⅛" clear acrylic plastic domes won't discolor, craze or crack with age. Odorless, non-toxic & non-conductive. Rim permits screwing down to prevent pilferage; and combining 2 into a ball with small screws or cement for a creative project.

No. 71,710N (7" dia., 3-9/16" dp) ..... **$3.15 Ppd.**
No. 80,179N (12" dia., 6" dp) .....**$7.00 Ppd.**
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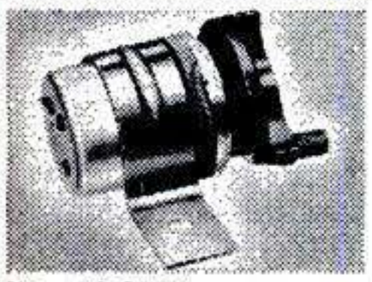
WAR SURPLUS ELECTRIC GENERATOR



Brand new Signal Corps Model. Up to 90 volts by turning crank. Use in high impedence relays. Charge ground & bring up night crawlers for bait or study. 2 Alnico Magnets alone now worth more than original $15 gov't cost.

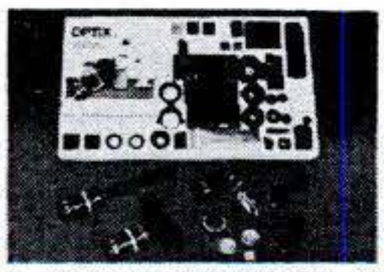
No. 50,225N .....**(2lbs.)**.....**$8.50 Ppd.**

KNOW YOUR ALPHA FROM THETA!

Learn to control your Alpha-Theta brainwaves for relaxation, improved memory, concentration. Head electrodes, hooked to amplifier, filter brainwaves signaling audible beep for each Alpha-Theta wave passed. Wrist & finger contact pick up and amplify heart beat, skin resistance. Reliable, easy-to-use trainer unit offers features comparable to many higher-priced modes. Completely safe. Most people can learn Alpha rhythm control in 10-12 hrs with full instructions included.

Stock No. 71,606N .....**$120.00 Ppd.**

130 EXPERIMENTS IN OPTICS . . .



and photography! Optix(R) Experiments Kit is a complete optical & photography lab for 130 exciting experiments. Lets you recreate the periscope, telescope, microscope, kaleidoscope! Build a 35mm reflex camera with interchangeable lens system! Make, develop photographic film! Enjoy the fun and fascination of having your own optics lab. Fully illustr 112-pg manual, 8½"x11", clearly explains usage of this stimulating kit's 114 precision engineered components.

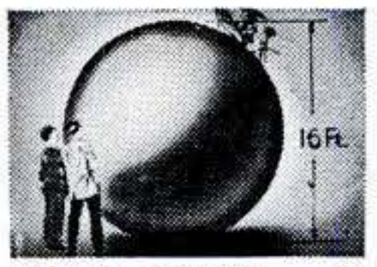
Stock No. 71,646N ..... **$21.00 Ppd.**

BUILD A "PRO" WEATHER STATION

Meteorology kit can give you the know-how to check your predictions against official forecasts! Has remote reading anemometer w/windvane. Indoor indicator board flashes neon, shows wind speed, direction. Safety power cord holds current to less than 1 ma. Also: sensitive air-tank barometer w/2-ft. indicator column; sling psychrometer to measure rel. humidity; rain gauge that measures to 1/100th inch; 100 ft. lead-in wire; cloud chart; forecasting manual.

Stock No. 71,022N .....**$15.95 Ppd.**

GIANT WEATHER BALLOON



"Balls of fun" for kids, traffic stoppers for stores, terrific for amateur meteorologist. Create a neighborhood sensation. Great backyard fun. Exciting beach attraction. Amateur meteorologists use to measure cloud heights, wind speed and temp. Made of heavy duty neoprene. Inflate with vacuum cleaner or auto air hose; or locally available helium for high rise.

Stock No. 60,568N .... **(8 Ft. diameter)** ...**$2.50 Ppd.**
Stock No. 60,632N ... **(16 Ft. diameter)** ...**$7.00 Ppd.**

POWERFUL 22 OZ. RANGEFINDER!

Direct reading up to 2 mi. Has 3 interchangeable pre-computed scales. In seconds, get exact fix, check distance & speed, correct compass. Gives 210' field of view at 500 yds; less than 1% error at 50 & 100 yds. 6 x 18X monocular detaches for sep use. Ideal for hunters, boaters, golfers, engrs., contractors, estimators. Weatherproof. 2-yr warranty.

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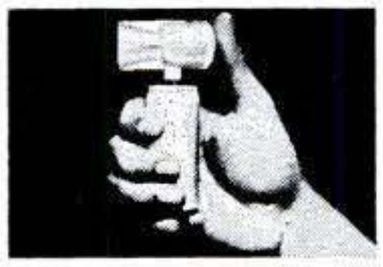
CARRY CASE & "IN USE" HOLSTER
Stock No. 71,649N .....**$7.75 Ppd.**

POWER HORN BLASTS A MILE



Frighten prowlers, muggers, vicious dogs with 118 decibels. Just press and this Freon powered pocket-sized horn can be heard a mile away to signal for help or fun. Great for boating (it floats), hiking, camping, hunting, seashore, rooting for your team. Can be heard over traffic and constr. noises to sound fire drill, lunch break or emergency. Weighs only 3 oz. but contains up to 100 mile-piercing blasts. A real bargain.

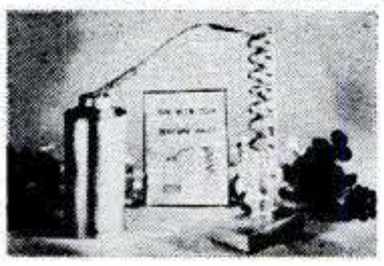
Stock No. 41,423N .....**$3.25 Ppd.**
Giant 9-ounce Air Horn.
Stock No. 71,630N .....**$8.25 Ppd.**

STEREO MICROSCOPE AT ⅓ PRICE

Mfr.'s surplus! Paired 10x Kellner eyepieces w/rubber eyeguards & paired 8X color corrected objectives for 30X overall. Left side focuses independently. Good definition; collimated; coated optics; long working distance (var. 1½-4"); interpupillary adj: 55-80mm; extends 9-13" overall. Removable diffusing plastic stage; helical rack & pinion for smooth focusing; lockable head swings 360 degrees. Lustre-coated metal, sturdy vibrationless base. 3½ lbs. Imported. Hurry!

Stock No. 71,621N ..... **.$59.50 Ppd.**

MAKE PERFUME WITH A "STILL"



Real "flower power"—why pay like $50 an ounce for perfume when you can make your own in 5 simple steps? You supply the flowers, animal fat and undenatured alcohol (100-proof vodka is ideal) — kit contains all equipment needed for small quantities. Enjoy making exotic perfume from favorite garden flowers—even turn it into Cologne, hand lotion, after-shave lotion, perfumed soap! Easy instructions. Creative, fun hobby to turn a profit!

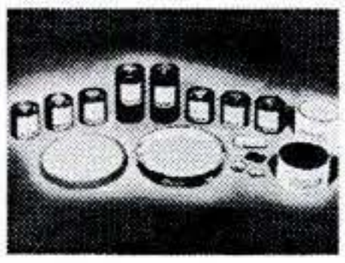
Stock No. 71,684N .....**$10.75 Ppd.**

AMERICAN MADE OPAQUE PROJECTOR

Projects illustrations up to 3" x 3½"—enlarges them to 35" x 30" if screen is 6½ ft. from projector, larger pictures if screen is farther away. No film or negatives needed. Primarily intended for children. Projects charts, diagrams, color or black-and-white in darkened room. 115 v A.C. . . . 6 ft. cord and plug included. Size 12" x 8" x 4½" wide. Weight 1 lb. 2 ozs. Plastic case.

Stock No. 70,199N .....**$8.75 Ppd.**

ASTRONOMICAL TELESCOPE KITS



Grind your own mirror for powerful telescopes. Kit contains fine annealed pyrex mirror blank, tool, abrasives, diagonal mirror, and eyepiece lenses. Instruments you build range in value from $75.00 to hundreds of dollars.

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4¼" diam., ¾" thick
..... **$10.75 Ppd.**
Stock No. 70,004N
6" diam., 1" thick
..... **$16.95 Ppd.**
Stock No. 70,005N 8" diam., 1⅜" thick ..**$24.50 Ppd.**
Stock No. 70,006N 10" diam., 1¾" thick
30 lbs. .....**$44.50 FOB**
Stock No. 70,007N 12½" diam., 2⅛" thick
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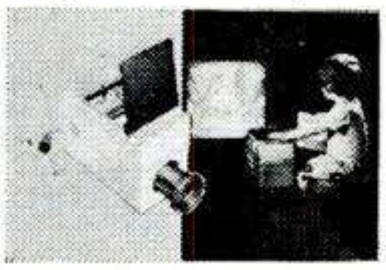
AMAZING NEW Wankel KIT!

Thrill to the fun of building your own see-through motorized model of revolutionary pistonless type engine . . . only engine experts think economically modifiable to meet new pollution standards. Replaces piston, cylinder, crank assemblies with rotating discs (sections removed for firing chambers). Smaller than conventional; fewer parts, greater reliability, same speed w/less horsepower. Feat: flashing plugs, rubber fan belt, stick-shift on-off switch. Req. 2—1.5V batt. (not incl.).

No. 71,424N .....**(4½" 5" x 9"**.....**$6.75 Ppd.**
519 Page Wankel Engine Book
Stock No. 9,439N .....**$15.25 Ppd.**

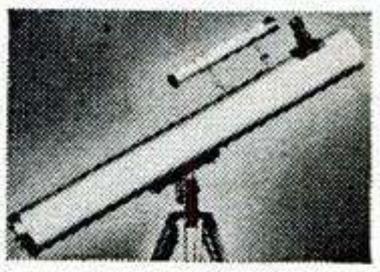
1st QUALITY OPAQUE UNDER $200



Terrific Buy! Top Quality! Projects brilliant, sharp 4½ ft. sq. image from 8' using up to 5"x5" color, b&w illustrations. Retains all original colors, proportions. Enlarges drawings, coins, maps, etc. Revolutionary peanut-size quartz Halogen lamp (50hr. life), 200 mm anastigmatic lens (f3.5,8"F.L.), unique internal reflecting system give maximum brightness, entire field focus. Can be used upside down. Turbo-cooled. 5½ ft. cord.

Stock No. 71,272N .... **(Wt. 11¼ lbs)** .... **$98.75 Ppd.**

3" ASTRONOMICAL TELESCOPE



See moon shots, orbits—stars, phases of Venus, planets close up, 60 to 180 power. Aluminized and overcoated 3" diameter f/10 primary mirror, ventilated cell. Equatorial mount with locks on both axes. Equipped with 60x eyepiece and mounted Barlow lens. 3x finder telescope, hardwood tripod. Included FREE: "STAR CHART"; "HOW TO USE YOUR TELESCOPE."

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DELUXE 3" APOLLO REFLECTOR
STOCK NO. 80,162N .....**$61.50 Ppd.**
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Anytime there's a balloon the air is festive. Especially when the "air" is helium, which makes a balloon perky and adventurous. Now here's 20 times the fun—20 various colored balloons of 4, 5, 6" diameter when inflated. With them, a pressurized (300 lbs/sq. in.) can containing 20 liters of helium to inflate all 20. For adults or kids' parties, giveaways bazaars or just demonstrating "lighter than air". Helium is a safe non-toxic inert gas.

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Best, easiest to use solid state metal detector at its price. U.S. made! Only 3 lbs! 6" search head detects penny at depth of 5", silver dollar at 8", bag of coins at 18". Easily works thru dirt, sand, wood, water (30" deep) and rock with no power loss. Detects your "find" sharply with "sound off" loudspeaker. Comes ready to go. One tuner control; all transistor; adjus. stem; perfect balance. Incls 9v batt. **FREE TREASURE GUIDE** To 101 Treasure Sites.

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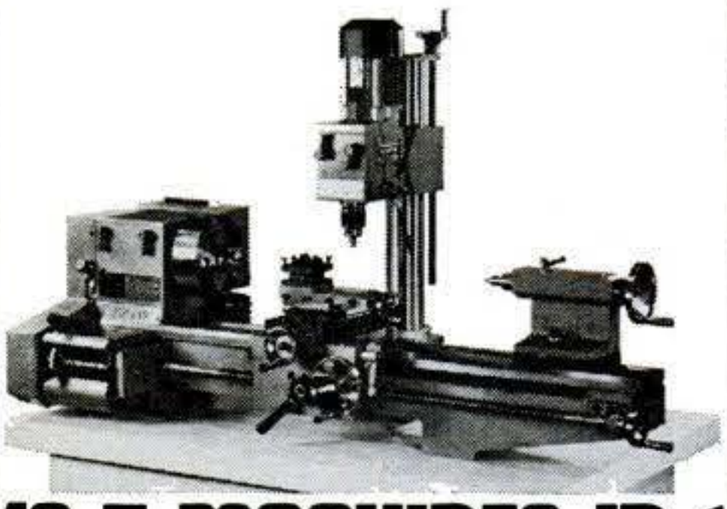
MODEL MAKERS MACHINING CENTER



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Versatile Maximat is *the* modelmakers machine, combining precision metal-turning lathe with vertical & horizontal mill, drill press, and grinder into one rugged and compact unit! Designed for labs and precision workshops, multi-purpose Maximat now fills the machine tool needs of serious craftsmen and hobbyists throughout the world. Three models available: 7" x 18", 7" x 24", 10" x 26". Maximat is fun and easy to use. Anyone can machine like a "pro" with our fully illustrated Maximat instruction handbook, Precision Machining Techniques — only $2. Dealers in all major cities. Use coupon for immediate information.

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Crisp Bacon in 90 Seconds

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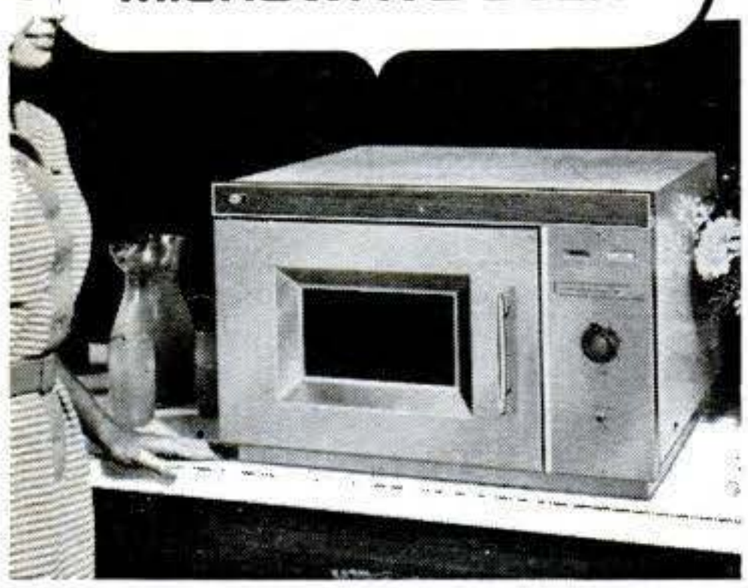
INTERNATIONAL'S MICROWAVE OVEN



People on the go will welcome an oven that makes cooking chores a pleasure. Imagine a "piping hot" TV dinner (frozen) in 3½ minutes* instead of 20 to 50 minutes. Bake a potato in 5 minutes* instead of 60 minutes. Fry crisp bacon in 90 seconds on a paper plate. Great for those leftovers. Countertop designed. Works on 115 vac house circuit. Write for folder.

*Times are approximate

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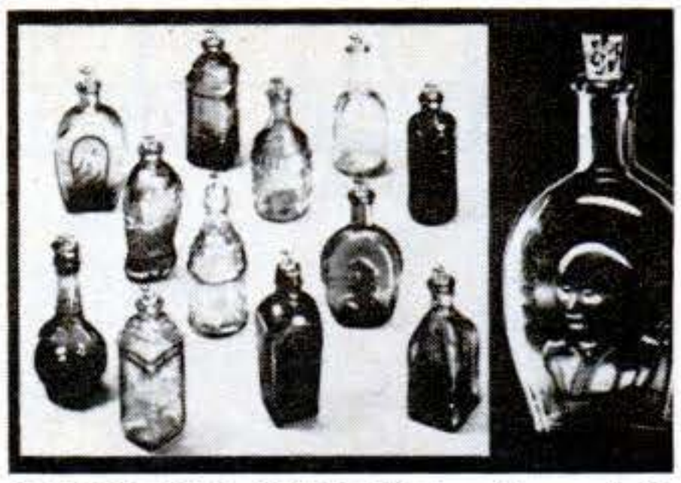

COLLECTOR'S MINIATURE replicas of 12 Early American Bottles & Flasks. Colors: red, amber, light & dark blue, green, amethyst. Bottles about 3" high, with real corks. Shapes include Ben Franklin, Liberty Bell & others. No. 4345, Set of 12 Antique Bottles, $2.98 + 35¢ pstg & hdlg. Foster-Trent, Inc., Dept. 555-AB, 2345 Post Rd., Larchmont, N.Y. 10538.

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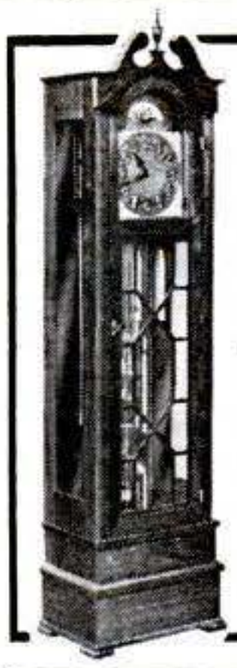

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GRANDFATHER CLOCK

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A true surplus bargain. Famous brand, new and American made to Government Specifications. Two models—3/8" square drive, 600 inch pound scale and 1/2" square drive, 100 foot pound scale. Sold nationally for $25.00. **Our price is $8.95** each, prepaid — U.S.A. — Money back guarantee. Cash, checks or money order. Immediate delivery.

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Sheets or cut to size and shape. Cabinet-Furniture-Dies-Jiggs-Marine-Aircraft. Fabricated component parts for volume production of any woodproducts.

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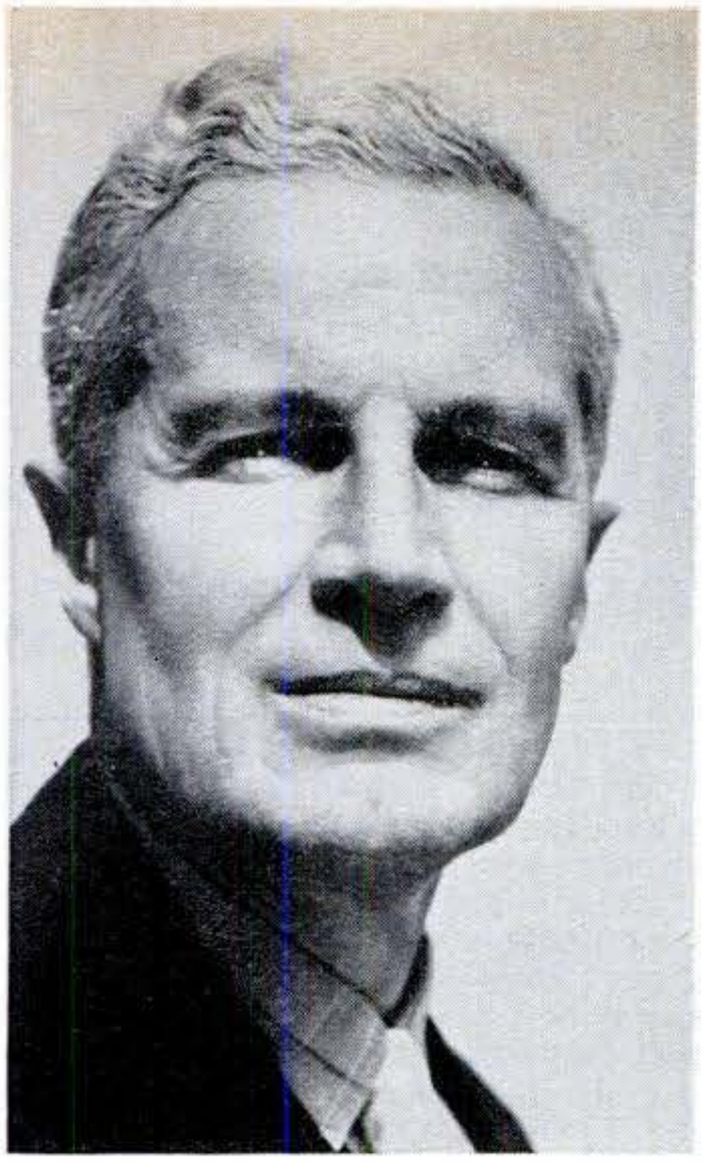

I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be — today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish!* And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned!* I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest $15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

VICTOR B. MASON
1512 Jarvis Ave., Suite M-3-CA
CHICAGO, ILLINOIS 60626

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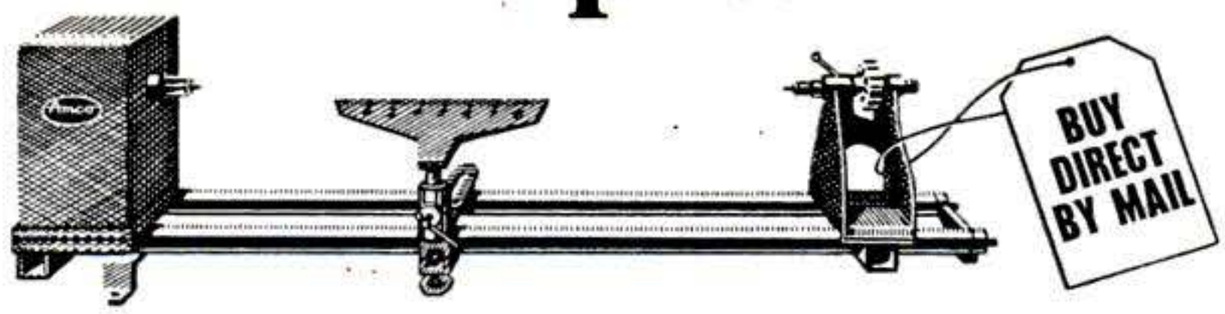
Unadorned power tools.



4' Wood Lathe at $29.95

They do the same job as tools costing up to 5 times as much.

We skipped the chrome to save you money . . . but we did not skip anything on performance. Actually, we skipped more than just chrome, we cut out every costly frill that wasn't absolutely needed.

The lathe shown above isn't exactly flashy. We admit it. But in a recent article, Popular Science used it to demonstrate wood lathe technique and said: "You won't go wrong with this economical introduction to wood turning." It is typical of our tools which in spite of low prices, are full scale and offer full performance and precision.

HERE'S HOW WE DO IT . . . First, we don't claim our tools should sell for five times the price! Just that our tools do the same job . . . with the same accuracy, ease and speed . . . and will last at least as long. AMT tools cost less to make and are sold direct. They are bona fide quality power tools used by serious amateurs and professionals alike and if sold in retail stores would be much higher in price. We use no magic, let's be specific:

SIMPLICITY . . . AMT tools are soundly engineered to eliminate every frill and gimmick—to minimize material and production costs. Machined parts are used only where they're needed. Unadorned cast iron and aluminum save you a fortune.

DIRECT-FROM-FACTORY SAVINGS . . . You save a bundle, yet, we offer a double guarantee backed by a 38-year-old company with millions of satisfied customers . . . and hundreds of orders pour in daily.

LARGE VOLUME . . . Our own foundry and large mass production facilities plus large buying power all work to keep costs down.

STANDARD PARTS . . . Our designs use standard hardware items wherever possible. By avoiding custom-made parts we pass on tremendous savings to you.

If you are looking for power tools that perform like units costing many times our low prices, order today and you'll be one step closer to many hours of woodworking satisfaction.

Bill Monty

POWER SAW

8" tilt arbor saw . . . crosscuts, rips, mitres, cuts compound angles, dadoes, coves, moldings. Completely assembled with ground cast iron table, safety guard, splitter, mitre gauge. Less blade, motor. Rip fence for easier work alignment, $3.50 add'l. Ball bearing model, $5.00 add'l. Takes ⅓ h.p. motor or larger, standard blades, attachments. Wt. 26 lbs., f.o.b. factory **$19.95**

FREE OFFER, cabinet base plans, . . . with one piece of ¾" plywood, convert your $19.95 saw into a floor model with a huge 27" x 24" top. Takes cabinet rip fence, $4.50 add'l.

TWO GUARANTEES

10-DAY MONEY BACK GUARANTEE
Try any of these power tools and compare it with any similar machine at any price. If not satisfied, return it for prompt, no questions asked refund! We pay the return shipping charges.

10-YR. FULL SERVICE GUARANTEE
Any part or parts of these AMT power tools (except motor which carries a one year guarantee) which become inoperative for any reason within ten years after purchase date will be repaired or replaced by the factory with no cost to the purchaser other than postage.

Brand new GE electric motor developing full 1 h.p. 17 lbs. (Purchased separately, $24.85). With any AMT machine here. **$19.90**

BUY DIRECT ...USE THIS HANDY ORDER COUPON NOW

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Please send me the units checked. Payment in full enclosed $_____ or $3 deposit each item enclosed, balance C.O.D. **I must be fully satisfied or will return unit within 10 days for full refund.** No questions asked.

- ☐ 8" Power Saw at $19.95
  - ☐ Standard Rip Fence at $3.50
  - ☐ Long Cabinet Rip Fence at $4.50
  - ☐ Ball Bearing Spindle at $5.00
- ☐ Belt Sander at $19.95
  - ☐ Disc Sander Attachment at $7.95
  - ☐ Mitre Gauge for Sander at $1.95
- ☐ Drill Press at $34.95
- ☐ Jointer Planer at $29.95
  - ☐ Ball Bearing Spindle at $5.00
- ☐ Wood Shaper Kit at $19.95
  - ☐ Opt. Hold Down Assembly at $2.75
- ☐ 6" Swing 3' Lathe at $14.95
- ☐ 12" Swing 4' Lathe at $29.95
  - ☐ Face Plate $2.50 (either Lathe)
  - ☐ Turning Chisels $4.95 (either Lathe)

G.E. Motor ☐ $19.90 (with other item) ☐ $24.85 (purchased separately)

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CITY _____ STATE _____ ZIP _____

3' WOOD LATHE

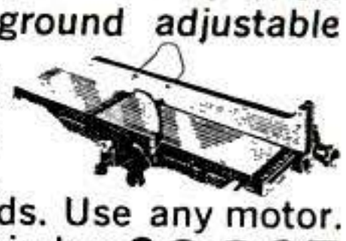
. . . 6" swing. Same precision and speed as $40 units. Sturdy cast iron with tubular steel bed. Lever action tail stock, two-speed pulley, fits any motor. Set of 3 high speed turning chisels, $4.95 add'l. 4" face plate, $2.50 add'l. 15 lbs., f.o.b. factory **$14.95**

4' WOOD LATHE

. . . 12" swing. Industrial size, does the same job as $75 units. Tubular steel bed rails, screw action tail stock, three-speed pulley. Use any motor. 3 high speed turning chisels, $4.95 add'l. 4" face plate, $2.50 add'l. 30 lbs., f.o.b. factory **$29.95**

JOINTER-PLANER

4⅛" x 22". Cast iron and steel, precision ground adjustable tables. For planing, joints, bevels. Rabbets to ⅜" depth. Fence adjustable 0° to 50°. Steel knives, dual guards. Use any motor. Precision ball bearing industrial model, $5.00 add'l. Wt. 19 lbs., f.o.b. factory **$29.95**

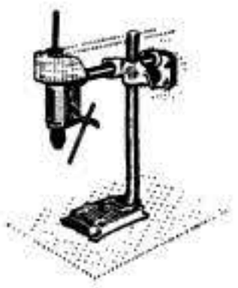


BELT SANDER

A precision unit. It changes from horizontal to vertical in seconds. Heavy, sander includes 4" x 36" sanding belt. Uses ⅓ h.p. or larger motor. V-pulley drive and multi-purpose drive spindle. Disc sander accessory, $7.95 add'l. Mitre gauge, $1.95 add'l. 15 lbs., f.o.b. factory **$19.95**

DRILL PRESS

Precision 32" radial unit has standard features and many extras. Depth of throat up to 16". Head tilts and table stays level. Drills to center of a 32" circle. All cast iron and steel. Takes standard motor. 32 lbs., f.o.b. factory. **$34.95**



WOOD SHAPER KIT

Makes beads, coves, moldings, tongue-and-groove joints, etc. Accurate cuts at high speeds. Sealed greased-for-life ball bearings. Less wood. Takes ¼ h.p. motor or larger, standard cutters. Optional hold down assembly, $2.75 add'l. 15 lbs., f.o.b. factory **$19.95**

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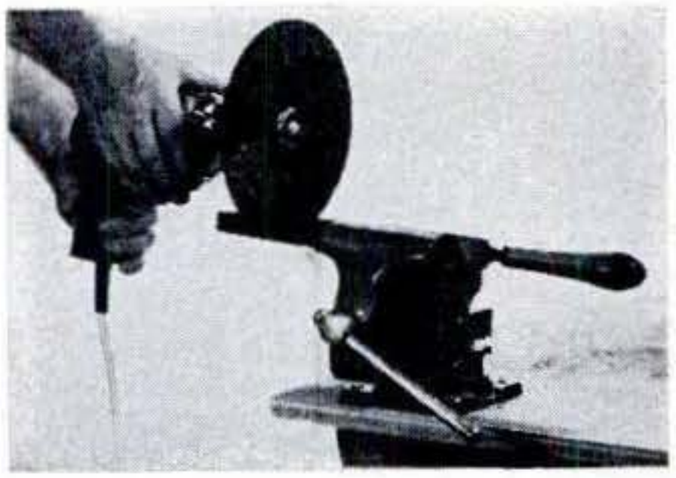
Shoppers'



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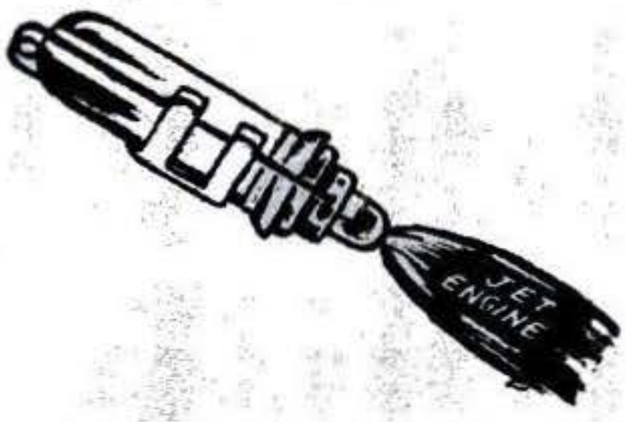

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capacity discharge ignition NOW

the ultimate in stepped-up performance, reduced ignition maintenance

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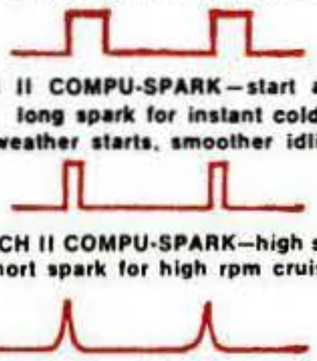

MACH II COMPU-SPARK—start and idle long spark for instant cold-weather starts, smoother idling

MACH II COMPU-SPARK—high speed short spark for high rpm cruising

Other CD electronic ignitions—all speeds

MACH II COMPU-SPARK installs in 10 minutes with any stock ignition. No re-wiring necessary.

This system for 12-volt neg. ground.

Exclusive: An antitheft switch makes car instantly inoperable at owner's discretion. A third switch position converts to standard ignition for testing.

DOUBLE GUARANTEE!

Use it 30 days—if the increased performance isn't worth it, send it back for a full refund.

Use it 3 years—if any part becomes defective in that time we will replace or repair MACH II COMPU-SPARK free.

*Chrysler, Mercedes, Jaguar, Ferrari, Porsche 1973 models are equipped with factory electronic ignition systems.

"Electronic ignition" is the new magic phrase in Detroit—automakers* have just started to install it. Soon it may be on all new cars. MACH II COMPU-SPARK offers you electronic ignition NOW.

MACH II COMPU-SPARK is a capacitive discharge ignition, the ultimate electronic ignition offering features advanced far beyond automakers' versions. It eliminates distributor point wear, extends spark plug life to 70,000 miles, eliminates plug fouling, cuts gas consumption up to 20%, reduces ignition tuneups by 75%.

No other electronic CD ignition system offers you **all** these outstanding features:

1. A 60,000 volt spark, 10 times hotter than stock ignitions, for instant starting in coldest weather, smoother running anytime.
2. Exclusive COMPU-SPARK circuitry—the only electronic ignition system with a brain—to automatically adjust spark length to engine rpm. The scope patterns tell the story. The COMPU-SPARK feature also restores performance lost due to smog control equipment, substantially reduces combustion contaminants and power loss.
3. All silicon semiconductor construction. Pioneered by MACH II in the 60's in electronic ignition, silicon components are immune to vibrations and to heat encountered under the most sizzling driving conditions. Silicon semiconductors remain undamaged even over 300°; germanium transistors, still used by most other CD ignitions, break down at 170°.

MACH II COMPU-SPARK makes a modest claim: There is no system on the market that will provide better performance, more consistently and longer. Our double guarantee is based on that. If you can't buy a better system, why pay more?

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Please send immediately:
☐ MACH II COMPU-SPARK, ready to install @ $49.95 ppd.
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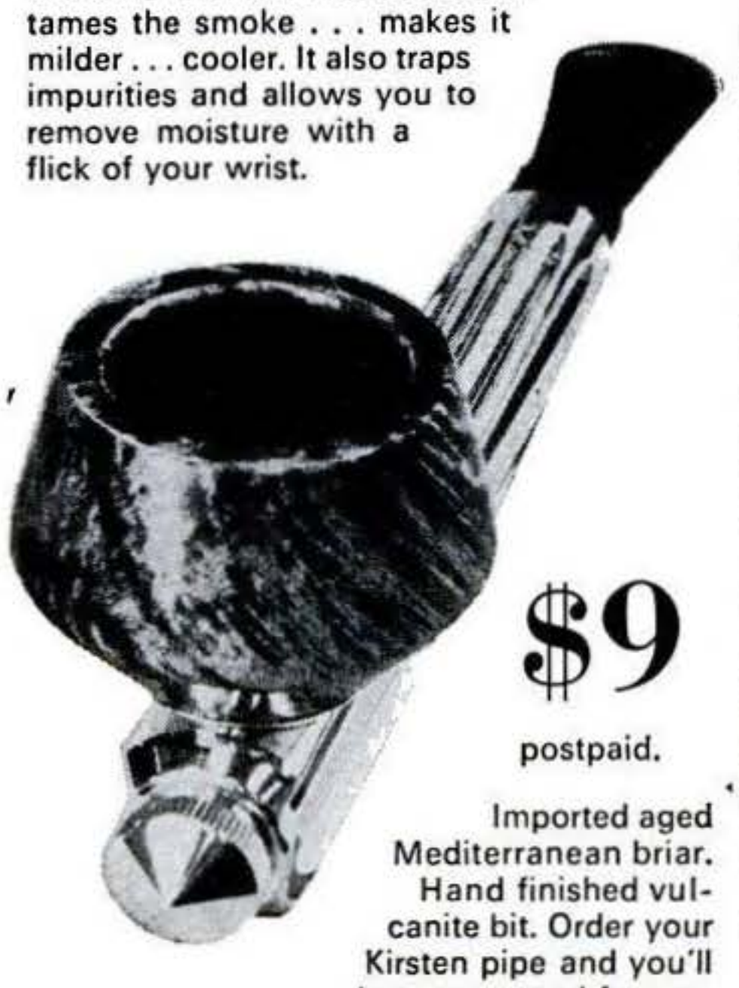
The pipe that never loses its cool.

Kirsten's exclusive radiator stem tames the smoke . . . makes it milder . . . cooler. It also traps impurities and allows you to remove moisture with a flick of your wrist.



$9 postpaid.

Imported aged Mediterranean briar. Hand finished vulcanite bit. Order your Kirsten pipe and you'll keep your cool forever.

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Please send me your 1973 catalog showing all of the Kirsten Pipes and accessories.
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Now the most enjoyable, do-it-yourself project of your life— a Schober Electronic Organ!

You'll never reap greater reward, more fun and proud accomplishment, more benefit for the **whole family**, than by assembling your own Schober Electronic Organ.

You need no knowledge of electronics, woodwork or music. Schober's **complete** kits and crystal-clear instructions show **you**—whoever you are, whatever your skill (or lack of it)—how to turn the hundreds of quality parts into one of the world's most beautiful, most musical organs, worth up to twice the cost of the kit.

Five superb models, with kit prices from $500 to around $2,000, each **an authentic musical instrument actually superior to most you see in stores.**

Join the thousands of Schober Organ builder-owners who live in every state of the Union. Often starting without technical or music skills, they have the time of their lives—first assembling, then learning to play the modern King of Instruments through our superlative instructions and playing courses.

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Weld, braze, solder or cut most anything made of metal. No experience necessary. Follow simple instructions to make repairs on cars, trailers, farm and lawn equipment, bicycles, appliances, etc. Make campers, boats, furniture, hundreds of valuable items. NOTHING ELSE TO BUY! Comes complete with full face shield, pack of welding and brazing rods, heavy duty power cables, special electric torch attachment, ground clamp, flux, easy-to-follow illustrated instructions, rod holder, etc. Uses standard 1/8" rods to weld iron, steel, brass, bronze, aluminum, other metals. New improved HEAVY DUTY circuit gives more welding power. Gives 4 times the heat needed to melt toughest iron. Plugs into ordinary 110V outlet. 6 WELDING HEATS plus continuously variable carbon-arc heat regulation control lets you weld anything from "tough" jobs to light-weight metals with ease. This important feature saves you money and time. Makes it possible for even beginners to start welding professionally the very first day. Pays for itself quickly. An excellent gift for any occasion. IT'S AUTOMATIC: Current is turned ON when arc is struck, OFF when rod is lifted from work. Eliminates need for troublesome foot switch. Speeds up work. Lifetime guarantee.

FREE! Mention that you saw this ad in Popular Science and receive a $7.00 gift pack assortment of "touch weld" welding rods. Automatic arc striker. Weld with "push button" ease.

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HANDY DANDY Storage JARS

Handy Dandy plastic caps hook onto 1/8" pegboard to hold popular, quarter-twist food jars (such as baby food) with 1-15/16" neck. Unbreakable, clear plastic jars are also available.

QTY	CAPS	JARS	CAPS & JARS
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24	-	4.50	-
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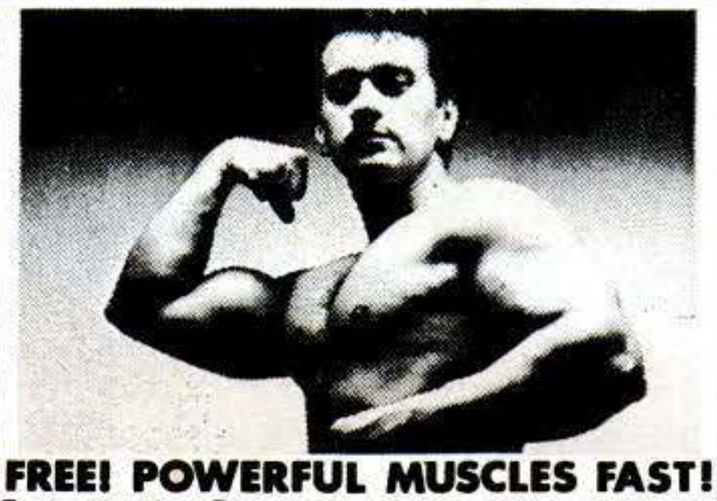

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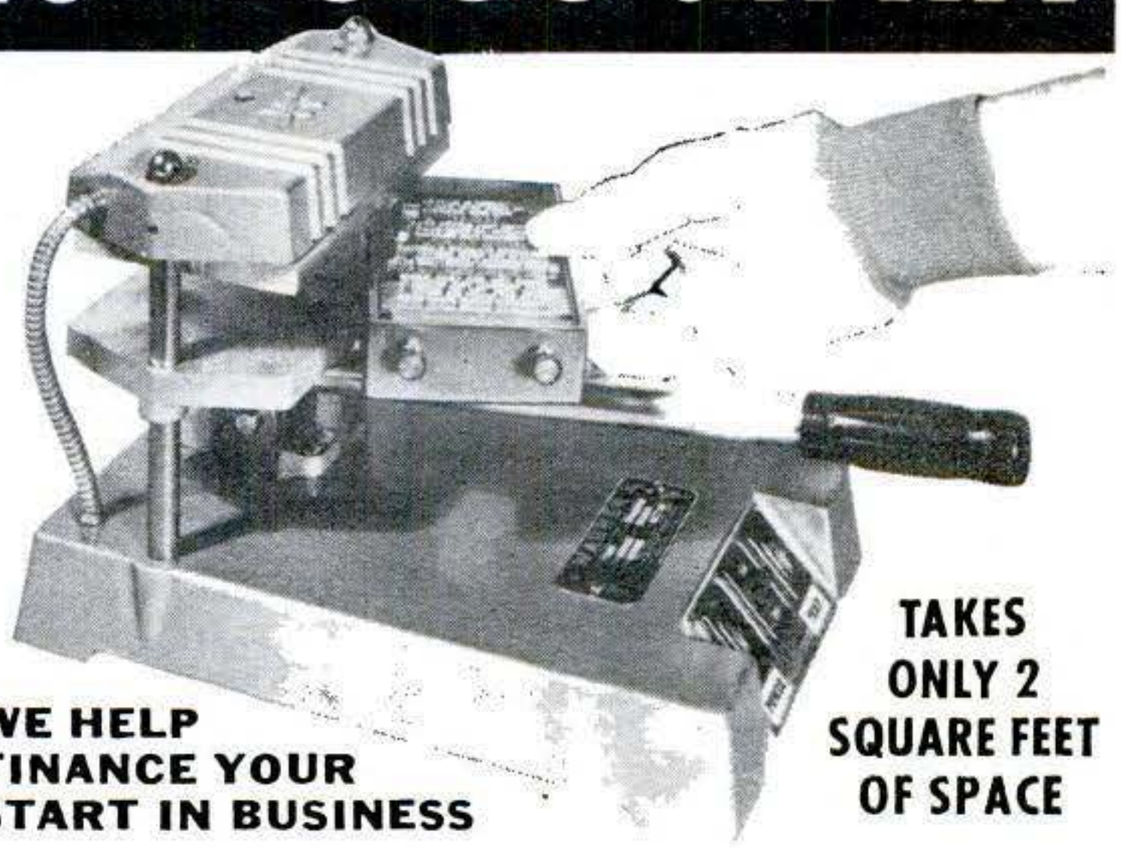

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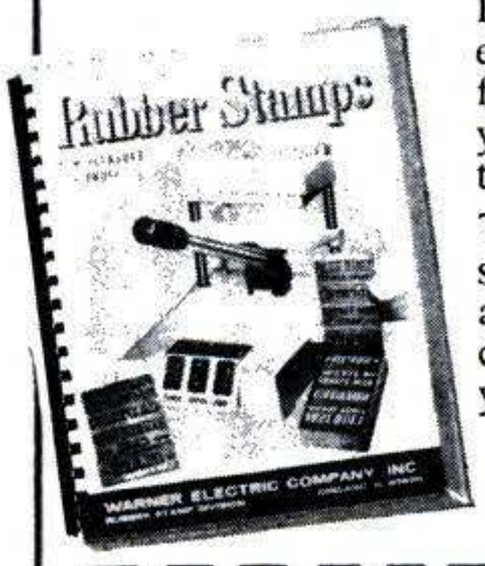

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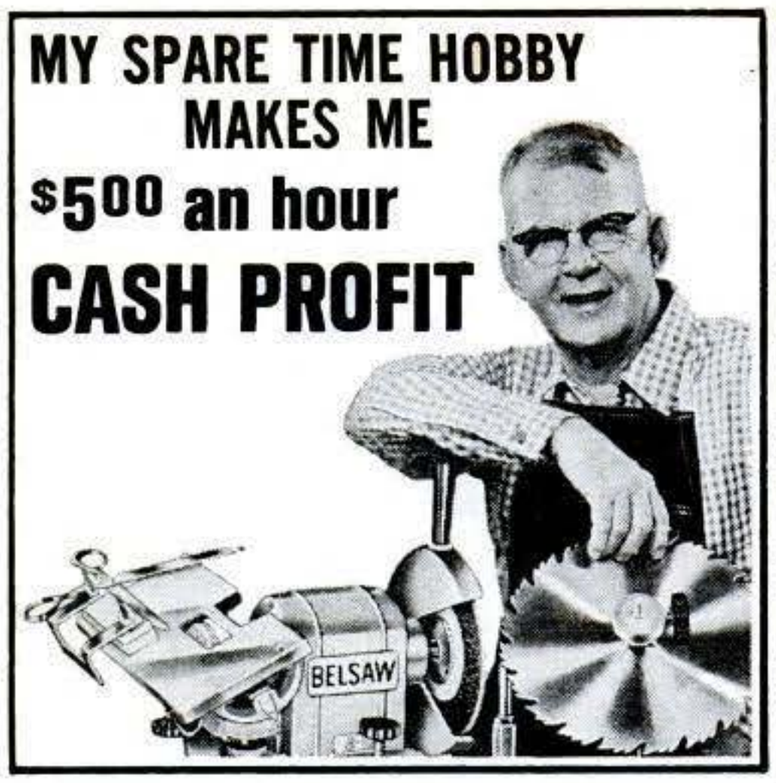

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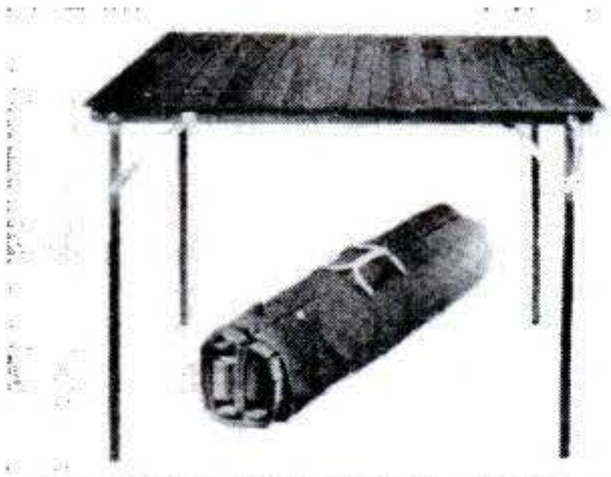

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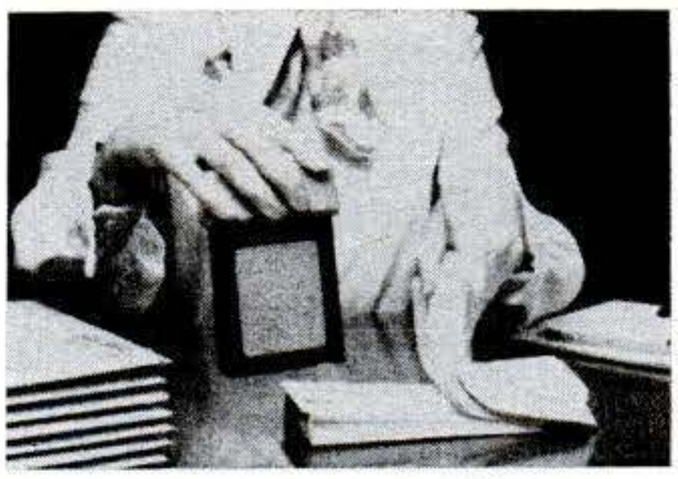

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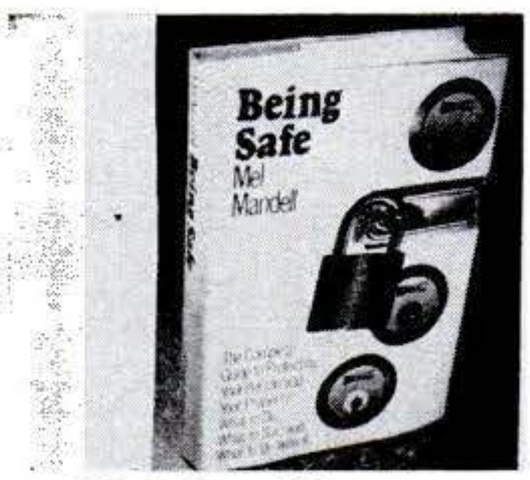

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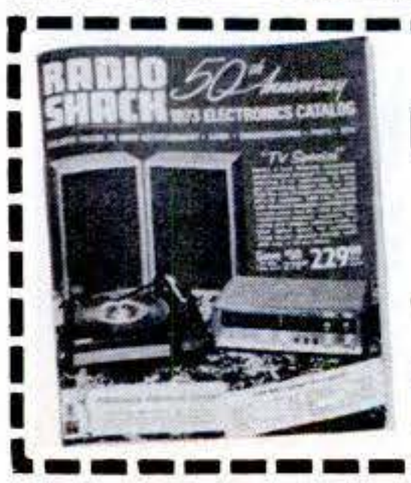

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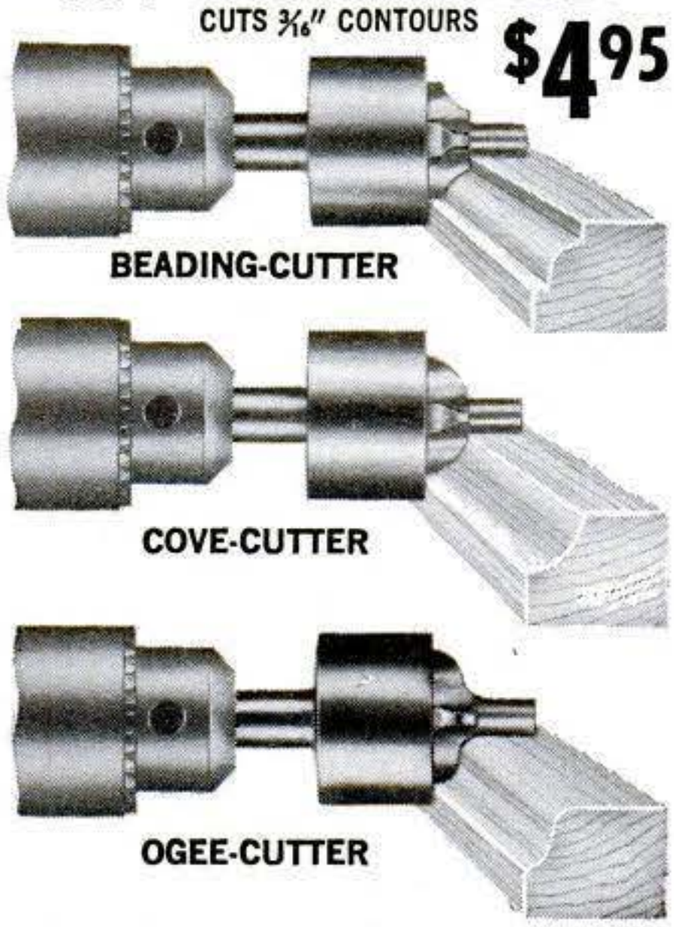

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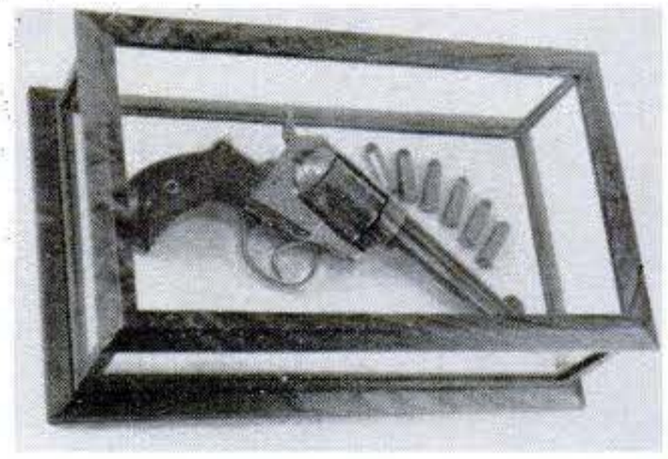

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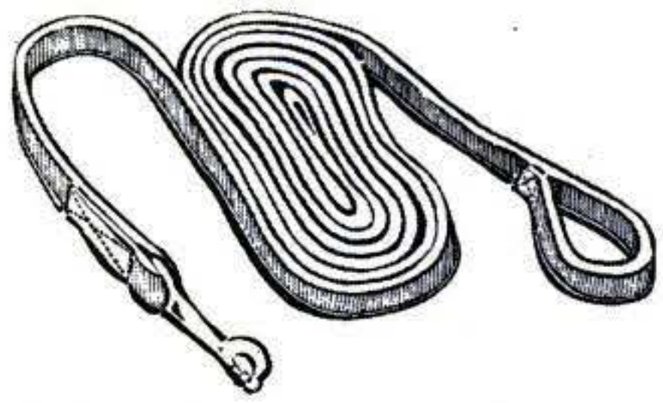

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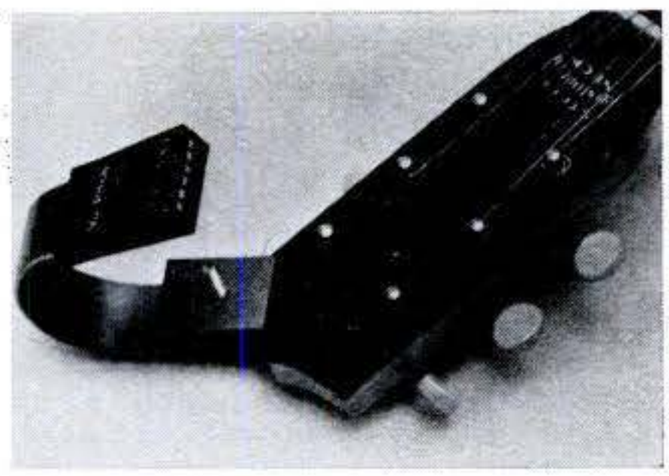

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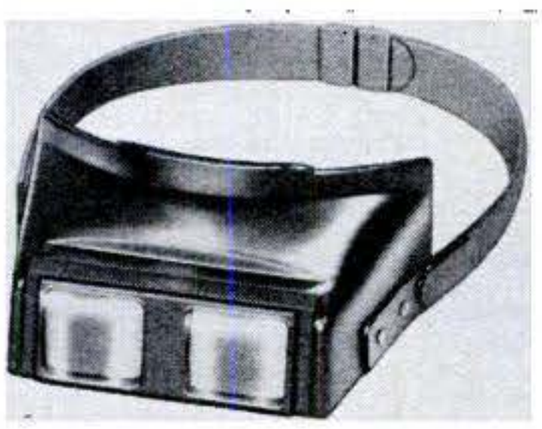

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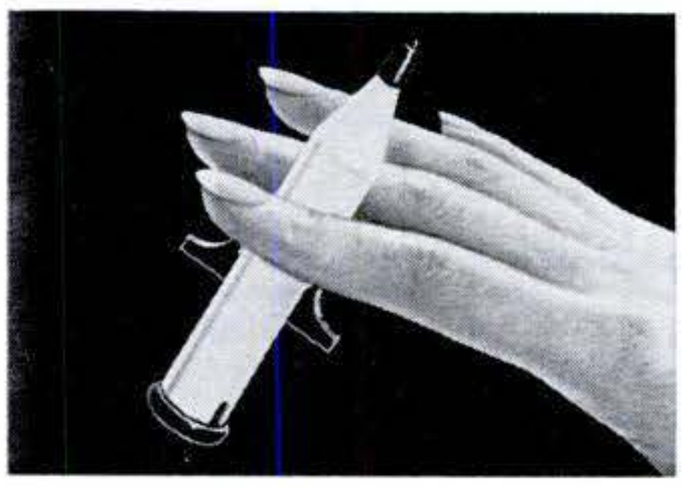

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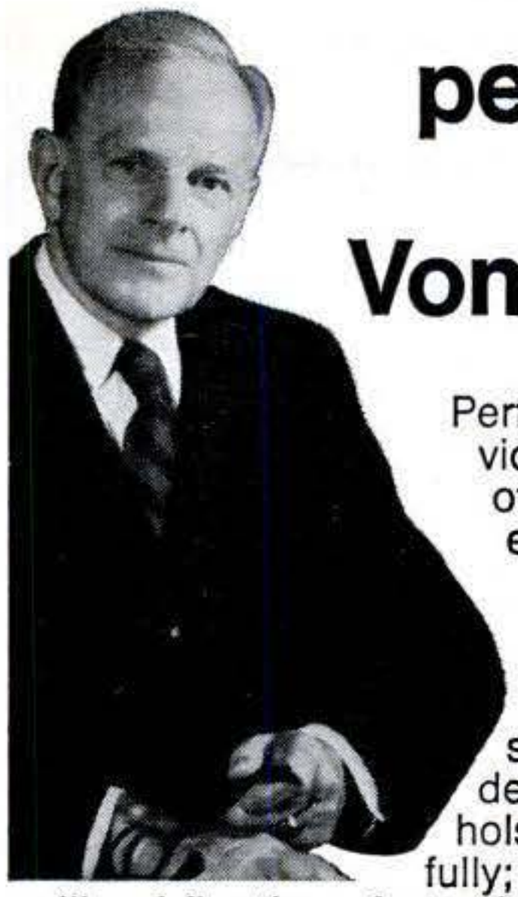

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WHEN WERE YOU LAST REALLY FIT?

AN EXPERT TELLS YOU HOW TO GET BACK IN SHAPE.

Even if you're not particularly interested in building he-man muscles, you owe it to yourself to keep your body fit. It's a sad fact of today's life that many men ignore this point and end up regretting it when they find they've become "old men" long before their time. Thanks to modern exercising techniques, "keeping fit" is now easier than ever. John Texier, Mr. France and leading fitness specialist tells you how.

Q. *What does fitness mean?*

A. For normally healthy people, fitness is a simple matter of maintaining muscle tone through exercise—using your muscles often enough and hard enough to keep them healthy and trim.

Q. *How does lack of fitness show up?*

A. The answer depends on how old you are. In your teens or early twenties, it's largely a matter of physical development. Young men with pipe-stem arms and caved-in chests aren't fit. With older men the first signs are usually a roll of fat around the middle and a lack of pep and energy.

Q. *Can sports keep me fit?*

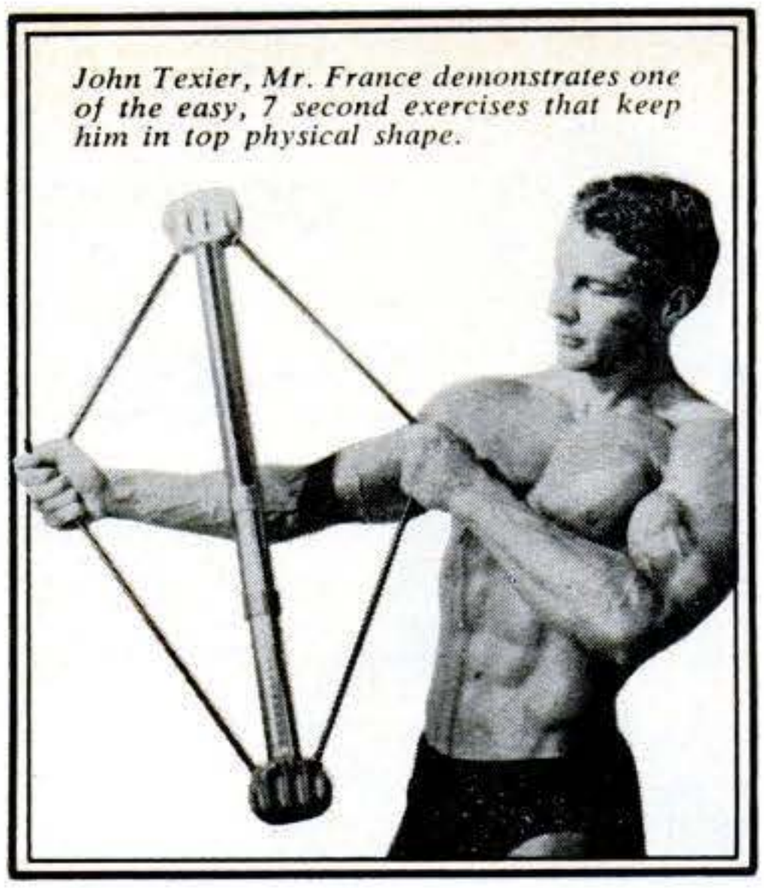
A. Yes, indeed, if practiced regularly and for long enough periods. Swimming, jogging, gymnastics, tennis, etc., can all help keep you fit provided you practice at least an hour three or four days a week—every week.

Q. *Isn't there an easier way?*

A. Yes, there's an outstanding home training method which I use and recommend. It's fast, easy and guaranteed to give results.

Q. *What's it called?*

A. Bullworker training. It's based on Isometric techniques which have been proven to increase strength faster than sports or conventional calisthenics.



John Texier, Mr. France demonstrates one of the easy, 7 second exercises that keep him in top physical shape.

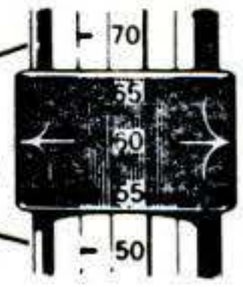
Q. *How long does it take?*

A. The 7-exercise introductory program requires only 70 seconds of exercise per day. The complete advanced training program takes about 5 minutes.

Q. *When do the results start?*

A. With the Bullworker, you can begin to see and measure positive results from the very first day! Isometric Bullworker training can increase your power at the amazing rate of up to 4% per week!

Built-in Powermeter
You can actually *measure* your musclepower g-r-o-w-i-n-g from the very first day.



Q. *But it's hard work, isn't it?*

A. Absolutely not! That's the outstanding advantage of Isometric training...it's so amazingly easy! Each "Staticpower" Isometric exercise takes only 7 seconds, and you barely have to move.

Q. *Is there an age limit?*

A. Generally speaking, men between 15 and 65 in good general health can expect to benefit from fitness and strength building training. Young men should use Bullworker to improve their muscular development: broad, powerful shoulders—rippling biceps—a deep, manly chest.

Men in their thirties should use Bullworker to maintain peak physical form and for toning-up the muscles of their abdomen, chest, shoulders and upper arms.

From 45 on, Bullworker should be used to regain and maintain a youthful vigorous body that belies the passing years. I've seen lots of Bullworker users in their fifties with more energy, power, and vigor than many younger men.

Q. *How can I find out more about the Bullworker.*

A. I understand that the American distributor is now offering the Bullworker on a two-week-free-home trial basis. If you're interested in getting back into shape fast, I recommend you contact the distributor for full details.

John Frelin shows how he increased his biceps by 2", filled out his chest by 4", his thighs by 1¼" in just a few weeks of Bullworker training.

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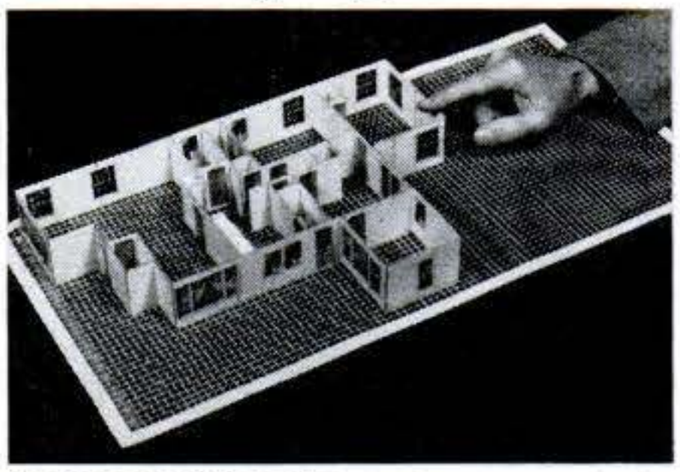

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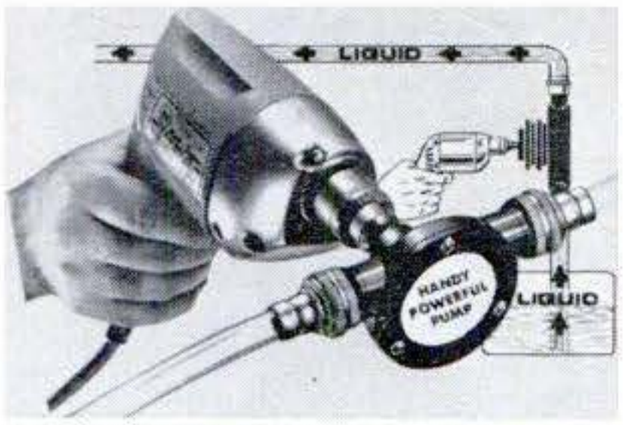

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How to get rich

How can you get rich some day? Make a hit record . . . a killing on the stock market . . . or invent a gadget like the hula hoop?

For most of us, these are just dreams. But have you ever stopped to think that there *is* a way to get rich—possibly only one sure way? Most fortunes, as you know, are made by people who own their own business.

Perhaps you've thought of starting a small business of your own . . . a franchised drive-in, or maybe a service business. Trouble is, you need $10,000 to $15,000 to get started and even then it's a gamble—with slim chance of ever making really big money.

But there is *one* business which could make you rich—almost overnight. And the beauty of it is, you can start on a shoestring during your spare time, even while holding your regular job.

Cash by Mail

The business is Mail Order—and it's fabulous! Come up with a 'hot' new item . . . and WHAM!

It strikes like a bolt of lightning!

Suddenly, you are deluged with cash orders from all over the country . . . MORE MONEY than you could ever make in a lifetime!

Like the Vermont dealer who ran one ad in Sports Afield Magazine. His ad pulled 22,000 orders—over A HALF MILLION DOLLARS IN CASH!

There is no other business where you can make a fortune so quickly!

• A beginner from Newark, N.J. ran his first small ad in House Beautiful—offering an auto clothes rack. Business Week reported that his ad brought in $5,000 in orders. By the end of his first year in Mail Order, he had grossed over $100,000!

• Another beginner—a lawyer from the midwest, sold an idea by mail to fishermen. Specialty Salesman Magazine reveals, "he made $70,000 the first three months!"

Proof

It's a fascinating business! Running ads in newspapers and magazines . . . mailing gift catalogs . . . getting cash orders in your daily mail—steady as clockwork.

There is no other business where you can start on a shoestring and pyramid your profits—*without investing in merchandise!* One husband and wife mail order team took in $40,000 selling one item. They obtained FREE ads in national magazines . . . didn't invest a cent in merchandise, and even got the supplier to ship all orders for them!

These exceptional cases are absolute proof that *you can get rich* in your own Mail Order business. Very rich. Even a U.S. Gov. Report stated: "A number of one-man Mail Order enterprises make up to $50,000!"

Pick up any magazine. Notice how the same mail order ads are repeated . . . month after month? That's concrete proof! You know those ads wouldn't be repeated over and over again—*unless* they were bringing in big cash profits to their owners.

The Secret

The secret of getting rich in Mail Order lies in *financial leverage*. It's a little-known, almost secret method—using other people's capital to make money for you!

You can get thousands of dollars worth of advertising in big national magazines—without investing your own money! And you don't have to write a single ad. Tested and proven ads are prepared for you by experts. Reinvest the profits from your first successful ad—to get more, larger ads, and the profits begin to snowball! It's like building a chain of stores . . . each new store puts more money in *your* pocket.

You mail out beautiful catalogs which offer hundreds of dollars worth of fine, quality gifts—yet you don't invest one cent of *your* own money

The thrill of receiving money in your mail is one you'll never tire of!

in merchandise! Your catalogs are printed with your name and address, so all orders come to you. Everything is "drop-shipped" for you, and there's up to *100% mark-up!* You pocket the cash profits immediately—even before the orders are shipped to your customers!

Repeat orders alone, just from mailing catalogs, could bring you a steady income for the rest of your life!

Yes, Mail Order is the fastest-growing, most profitable business in America! And now, with more people moving to the suburbs . . . the population explosion . . . and the expanding teenage market . . . we are on the verge of the BIGGEST BOOM in Mail Order history!

Now, with the help and backing of Mail Order Associates, Inc., of Montvale, N.J., you can follow the same proven steps to Mail Order success—using the 'secret' of financial leverage!

Start Now

We supply you with beautiful gift catalogs throughout the year. All products are drop-shipped for you, with up to 100% mark-up! You get free samples of top-selling mail order items, plus monthly trade reports on 'hot' new products . . . tested, successful ads are sent to you monthly. You get advertising directories, postal laws, complete courses, expert guidance—EVERYTHING you need to practically guarantee YOUR SUCCESS. Why? Because *our* business depends upon *your* success. It's mutually profitable!

A recent feature article in Income Opportunities Magazine stated, "Mail Order Associates Inc., offers the most comprehensive Mail Order program ever offered to beginners." They go on to say, "This could be the opportunity you've been looking for. A chance to get in on the ground floor in a little known business which we believe is on the verge of a new boom."

Free

We are now accepting a limited number of charter members in our new Mail Order Program. No previous experience is required but you must be over 21.

If you are sincerely interested in starting a profitable business on your own . . . if you can see the tremendous advantages which Mail Order offers . . . then ACT NOW!

Mail the coupon today, or simply send your name and address on a postcard. No salesman will call. We will send you a free book—gift catalog, reprints of feature articles, plus complete facts about our program. Write to:

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Please rush complete details on your Mail Order Program. I understand everything is free and there is absolutely no obligation. I am over 21.

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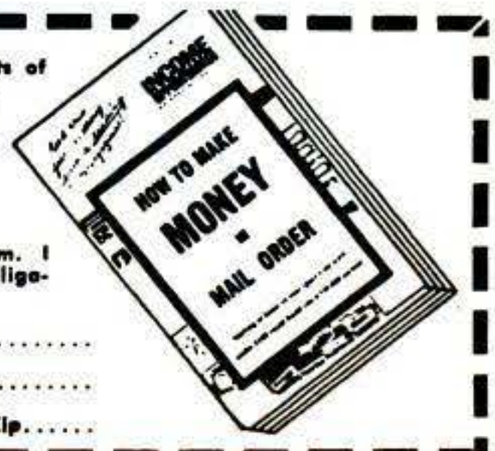

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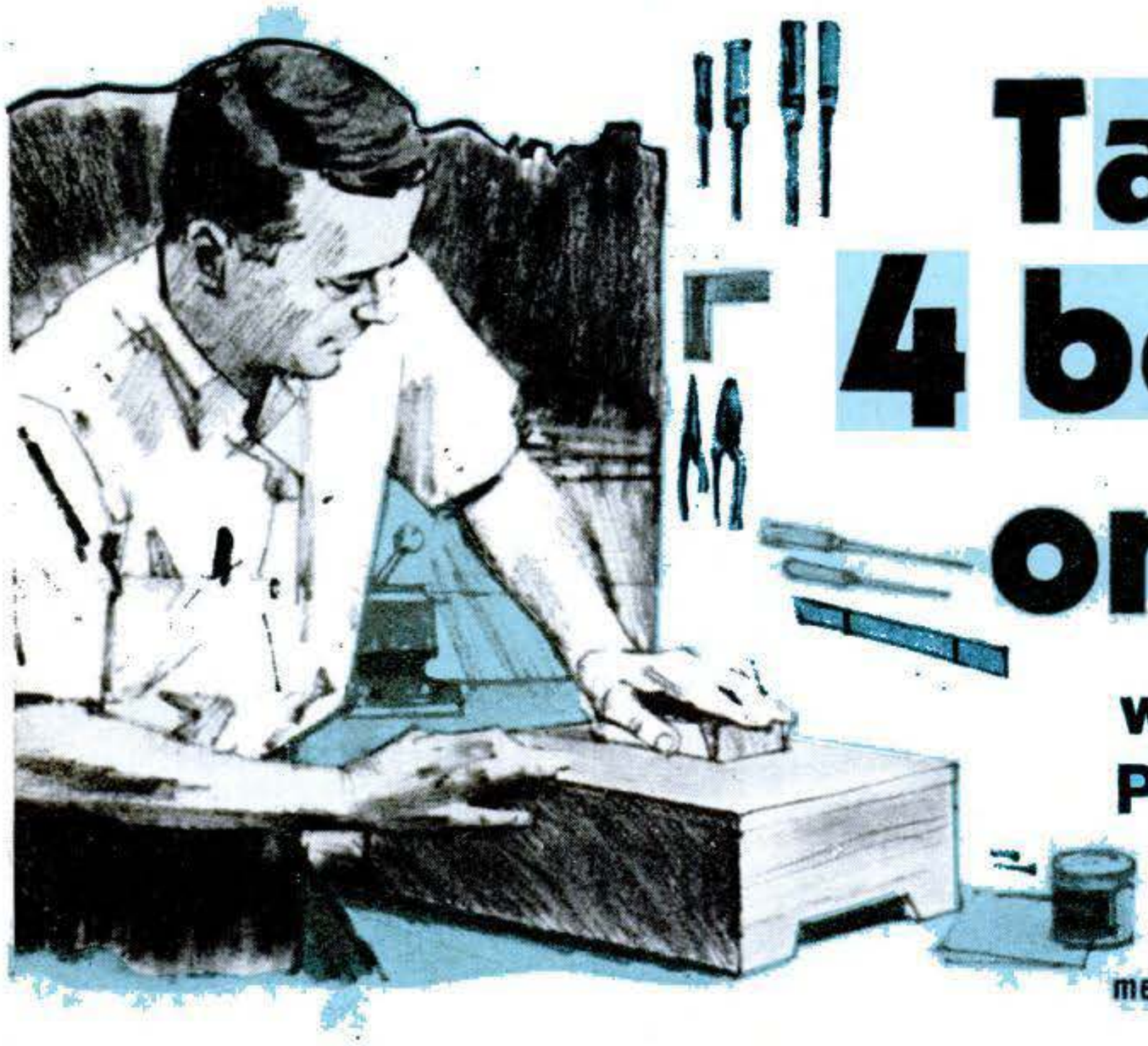

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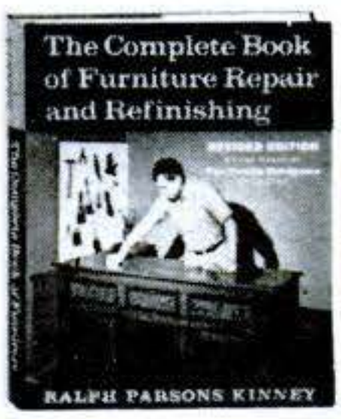

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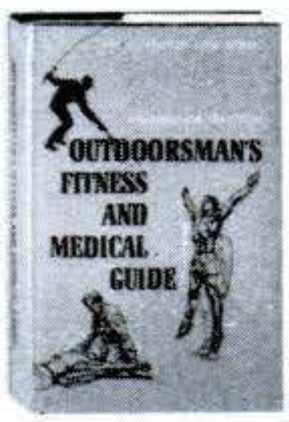

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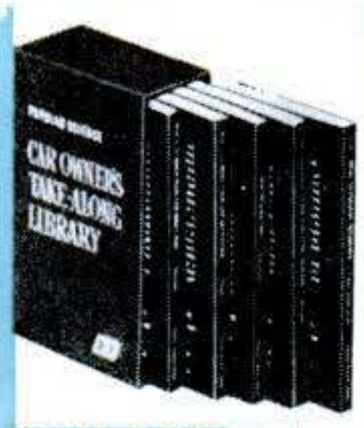

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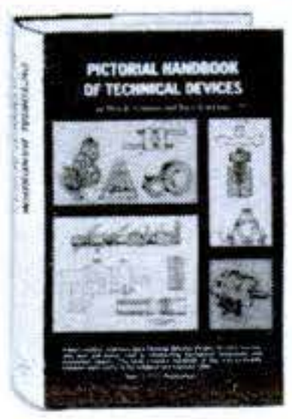

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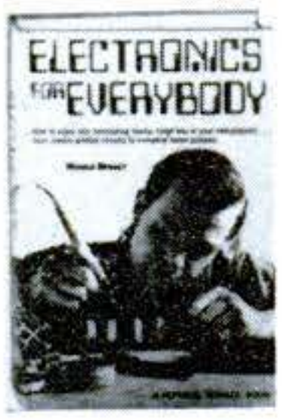

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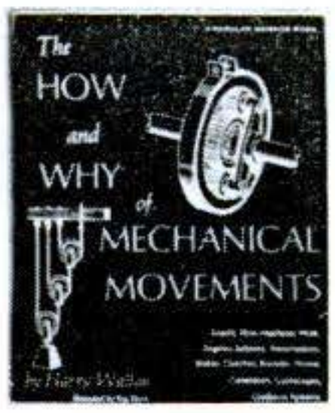

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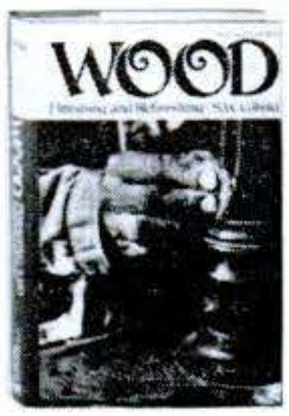

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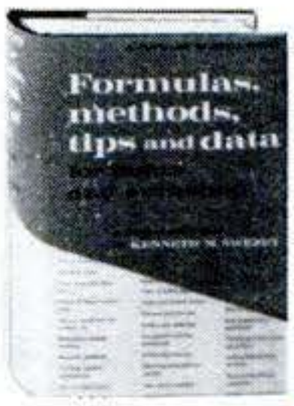

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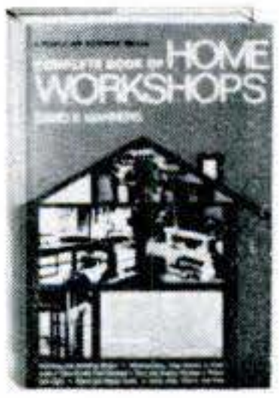

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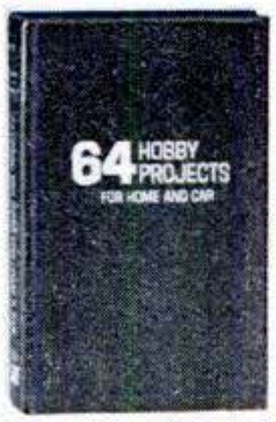

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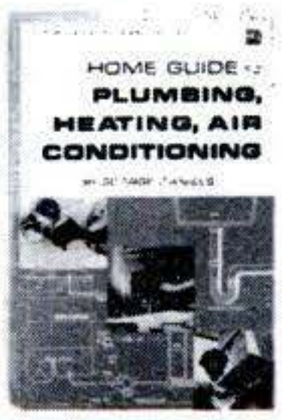

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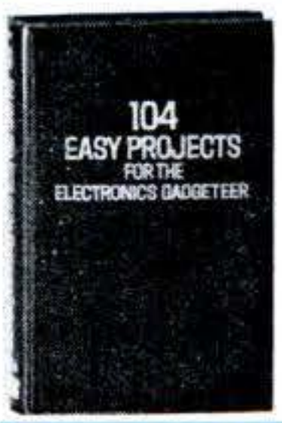

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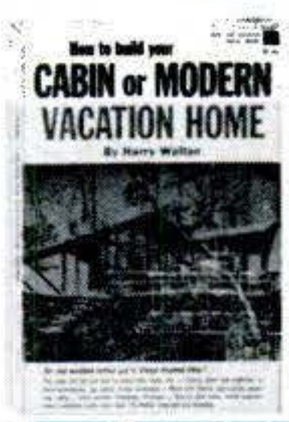

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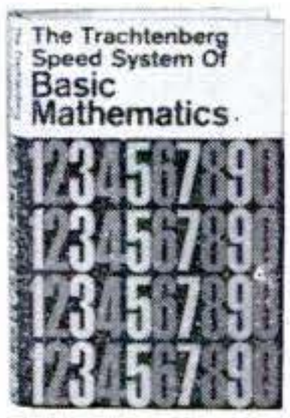

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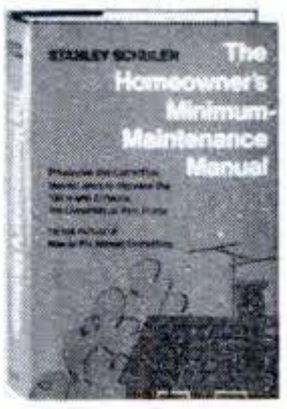

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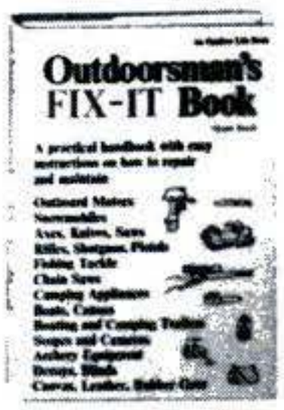

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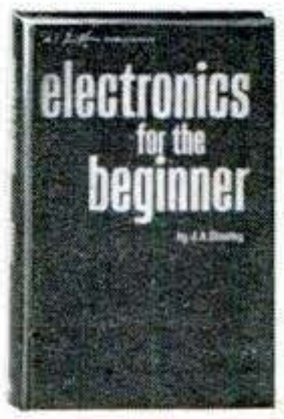

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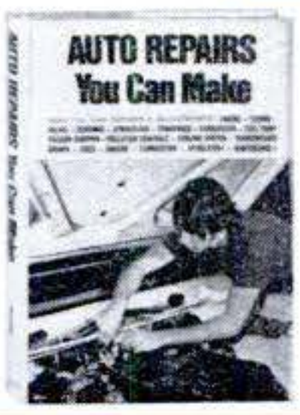

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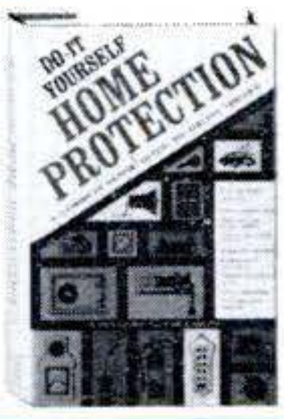

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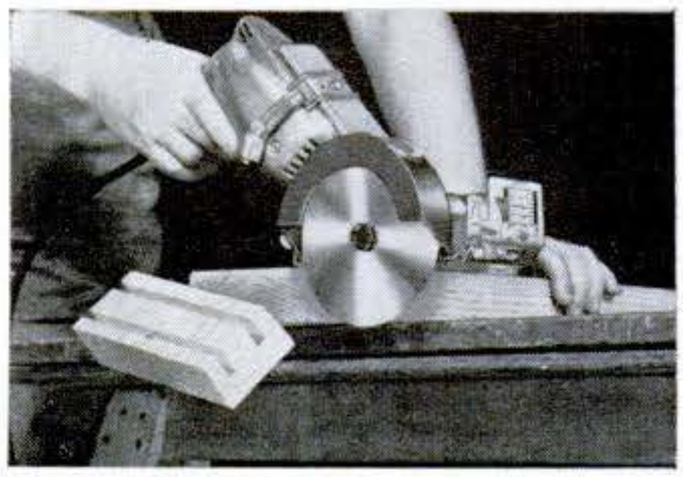

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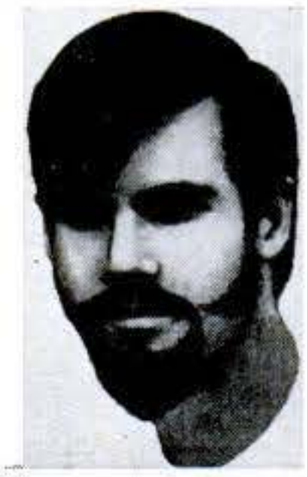

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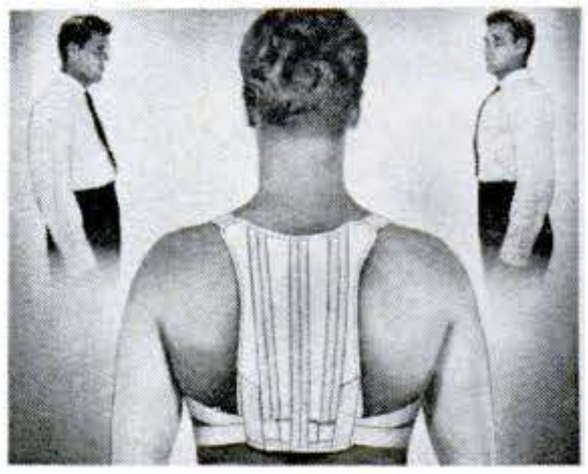

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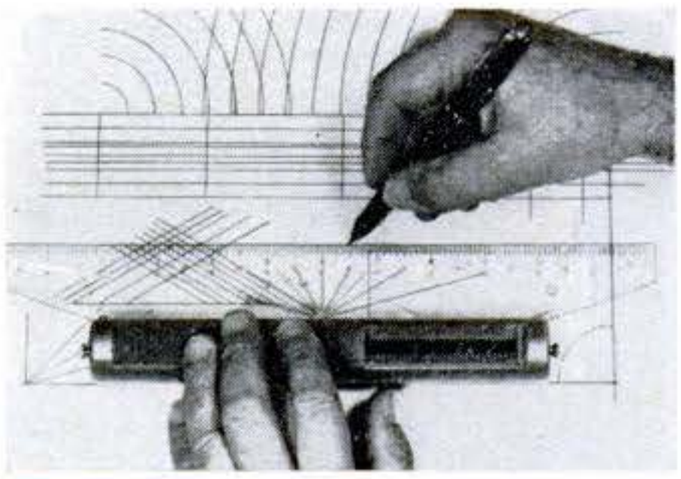

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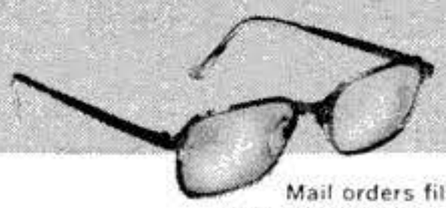

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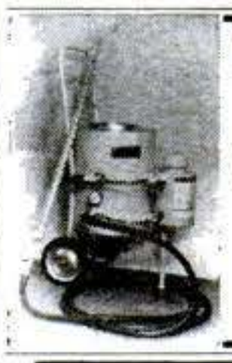

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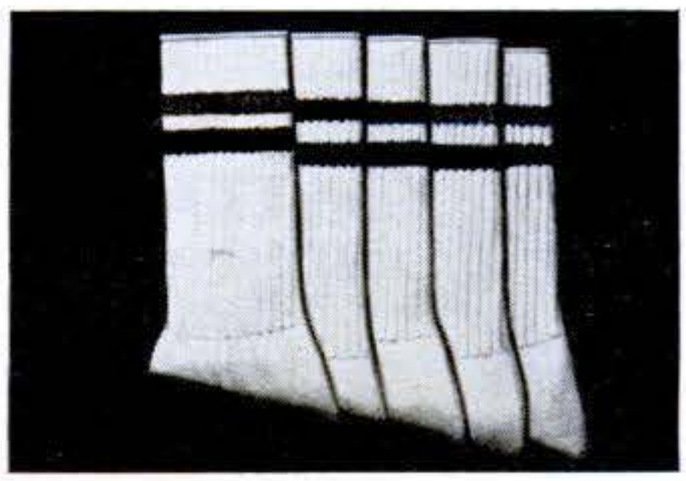

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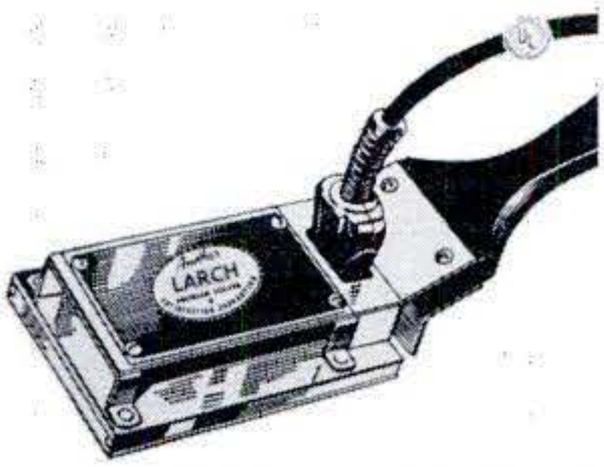

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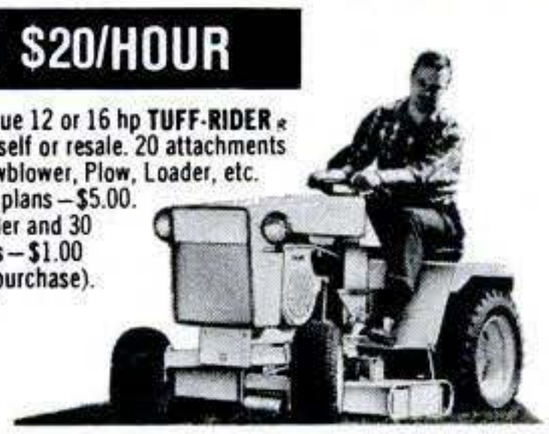

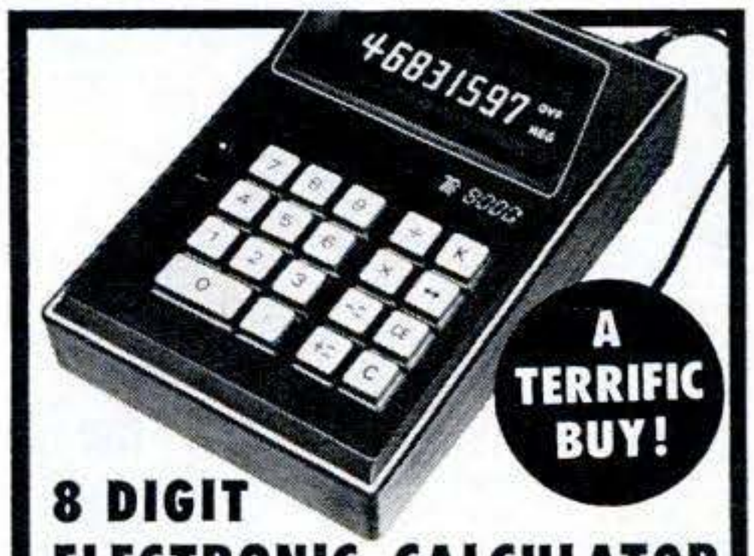

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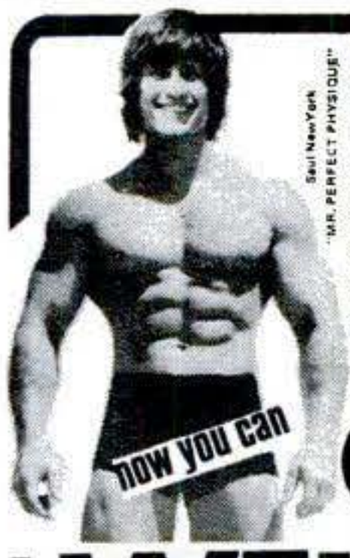

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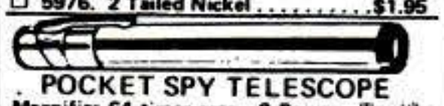

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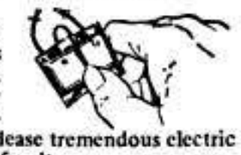

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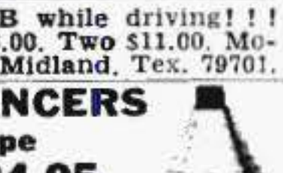

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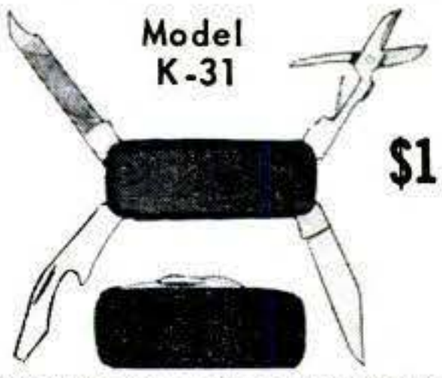

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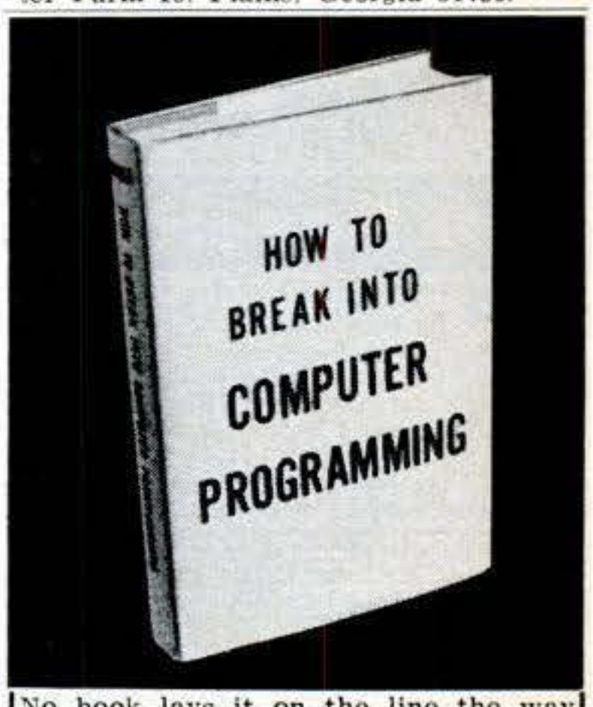

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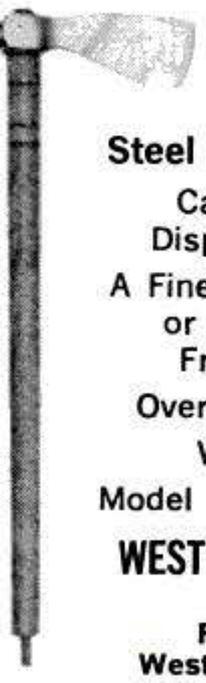

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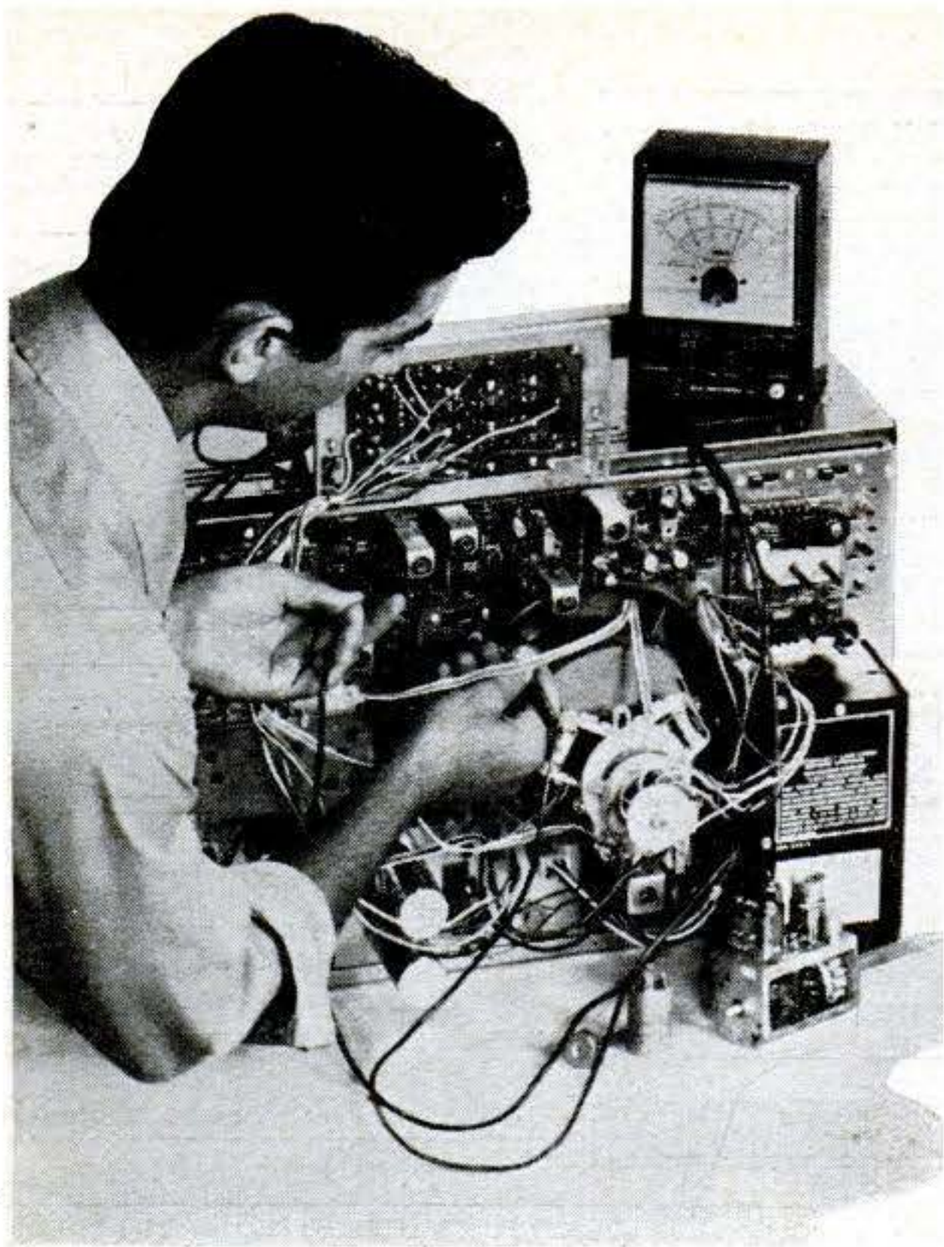

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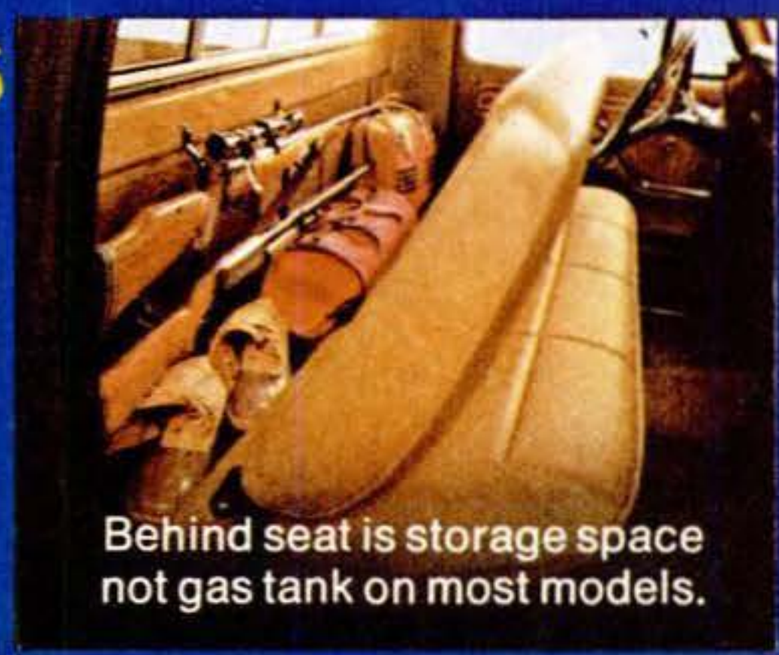
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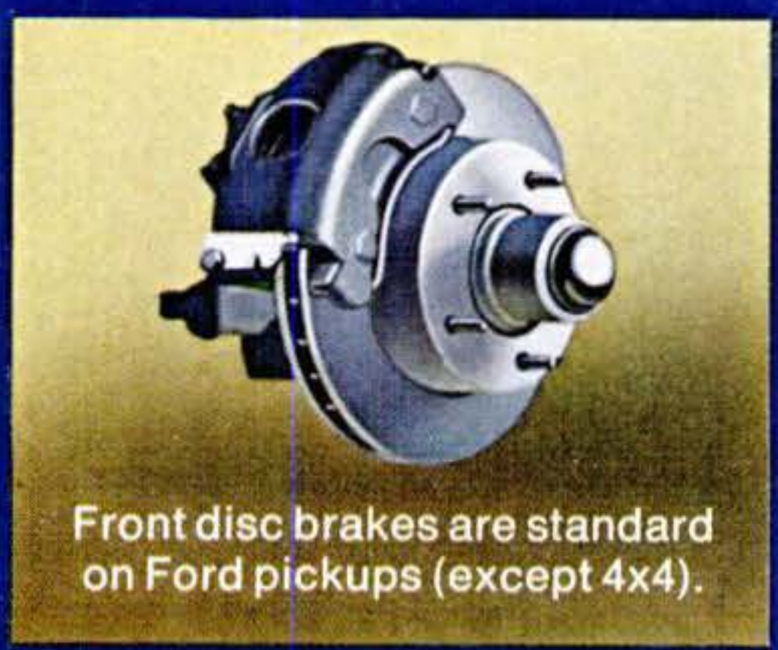
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